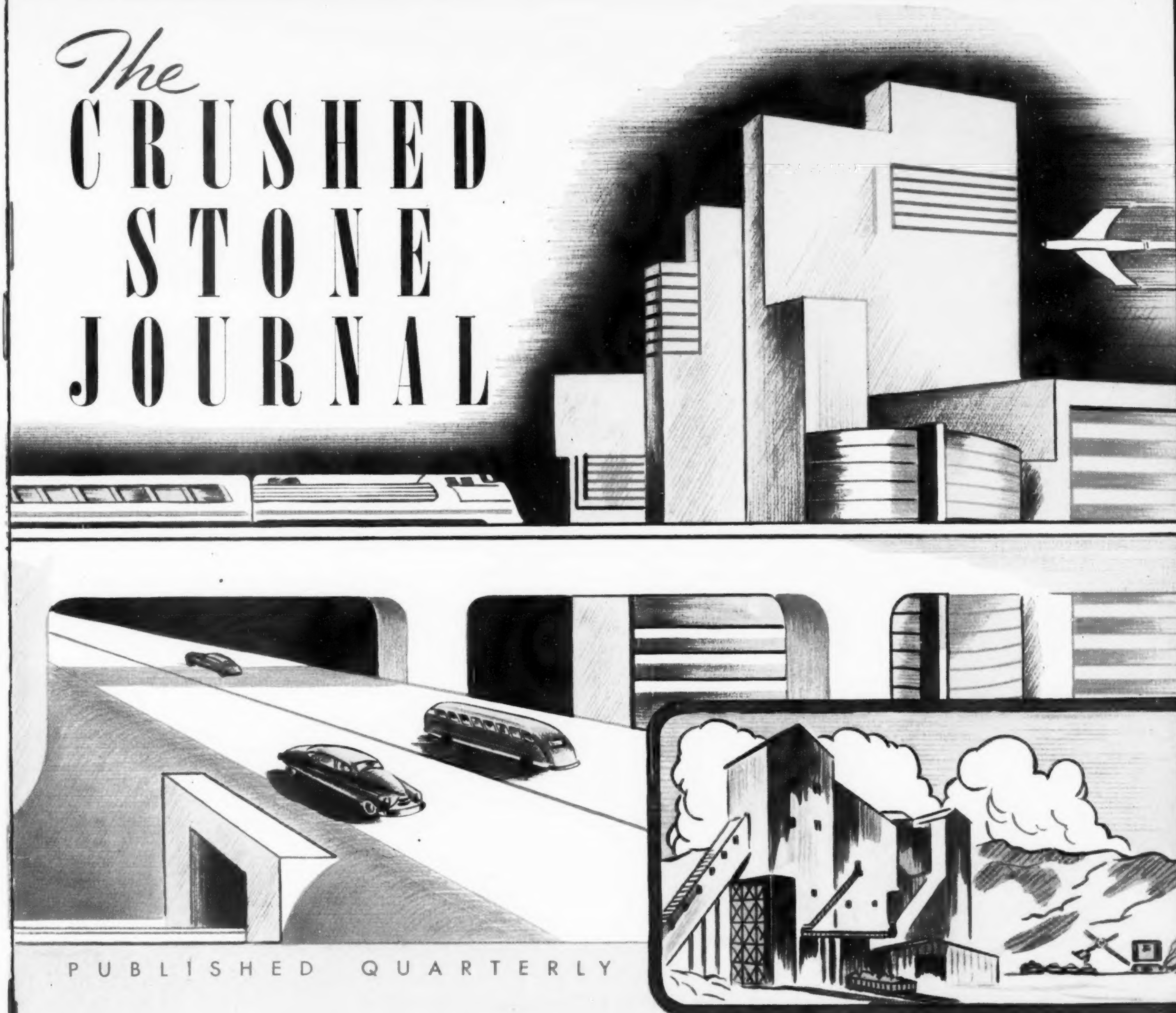
The CRUSHED STONE JOURNAL



PUBLISHED QUARTERLY

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December 1954

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- **Otho M. Graves—In Memoriam**
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OFFICIAL PUBLICATION · NATIONAL CRUSHED STONE ASSOCIATION

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of the
National Crushed Stone Association

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Single copies of the above publications are available upon request.

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Manual of Uniform Cost Accounting Principles and Procedure for the Crushed Stone Industry (*$2.00 per copy*)

The Crushed Stone Journal

Official Publication of the NATIONAL CRUSHED STONE ASSOCIATION

J. R. BOYD, Editor

NATIONAL CRUSHED STONE ASSOCIATION

1415 Elliot Place, N. W.
Washington 7, D. C.

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THE CRUSHED STONE JOURNAL

WASHINGTON, D. C.

Vol. XXIX No. 4 PUBLISHED QUARTERLY DECEMBER 1954

Quarry Operators to Meet in Cincinnati for 38th Annual Convention of NCSA

Advance Registration Forecasts Excellent Attendance

THE time again draws near for crushed stone producers from all sections of the country and from Canada to participate in that traditionally outstanding event of the year—the Annual Convention of the National Crushed Stone Association.

Scheduled to take place at the Netherland Plaza Hotel in Cincinnati, Ohio, on February 7, 8, and 9, 1955, this meeting promises one of the most stimulating, informative, and entertaining programs ever held in the long history of our annual conventions. No segment of the industry has been overlooked in the painstaking development of the subjects to be presented. Executives, salesmen, superintendents, and operating men—all will find much that appeals especially to them, not to minimize the several presentations of broad, universal interest which help so much to get us out of the groove of our daily routine affairs.

In the following are briefly set forth some of the highlights of the Cincinnati program. We sincerely believe that it is one of the best ever presented for your pleasure and profit, and urge that those who have not already done so immediately make hotel reservations. Truly, February 7, 8, and 9 in Cincinnati will be the "bargain days" of 1955 for crushed stone producers on the lookout for new operating ideas.

Following the formal opening of the Convention on Monday morning, February 7, President T. C. Cooke will give us the answer to the highly interesting question: How has the crushed stone industry fared during the current transition period?

The comments and observations made by President Cooke will be based on reports now being prepared for submission to him by our several Regional Vice Presidents. How your association has functioned in your interest during the past year will then be covered by reports from executive staff officers, Messrs. Goldbeck, Boyd, and Gray.

Seldom has a proposal in the highway field received such enthusiastic support from federal, state, county, and city officials as has the plan of President Eisenhower for a gigantic highway building program to cover the next ten years. The President's proposal is in the final stages of development prior to submission to the Congress. Pyke Johnson has been very closely associated with the President's proposal since its inception and will therefore know whereof he speaks when, as the concluding feature of the morning session, he addresses us on the subject "Significant Developments in the Highway Construction Program of Tomorrow."

For the Greeting Luncheon on Monday we have, indeed, a surprise, brought about by an unusual coincidence of happy events which brings the Countess Maria Pulaski, not only to this country, but to the vicinity of Cincinnati at the time of our meeting. The Countess served with great distinction as an espionage agent to one of our allies during the late war and under the caption "My Life as a Spy" will give us some of the highlights of her thrilling adventures which have made her name famous. She will be en route to Hollywood where a motion picture will be based upon her exciting experiences

and we are exceedingly fortunate in getting her to stop off in Cincinnati to talk at our Greeting Luncheon.

Superintendents and operating men will find attendance at the forthcoming convention a highly profitable experience. Being an off-show year, two full sessions, Monday afternoon and Tuesday afternoon, will be devoted to carefully selected topics chosen because of their practical value, and profusely illustrated with moving pictures and color slides. Full opportunity is to be permitted for discussion, and these two sessions prompted our earlier comment that February 7, 8, and 9 in Cincinnati are "bargain days" for those seeking new operating ideas. The program in detail for these two sessions has been sent to you in a separate mailing and therefore will not be repeated here. If you have entertained any doubt as to the value of coming to Cincinnati, a careful preview of the program for the Operating Men's Sessions should prompt you to immediately make reservations.

Come one—come all! to the Gay Nineties Party at 6:30 on Monday evening. To this gala affair everyone present at the Convention is most cordially invited. In an atmosphere of the nostalgic nineties and with excellent entertainment appropriate to that frolicsome period, you will have the time of your life. An old fashioned German dinner will be served at the tables during and after which there will be entertainment features and dancing. Plan to be with us on Monday night.

The general session on Tuesday morning will open with a report on percentage depletion by Russell Rarey, Chairman of the NCSA Percentage Depletion Committee, following which John F. Lane, of Gall, Lane and Howe, General Counsel for the Association, will discuss the Washington scene and the legislative outlook as related to the new Congress which convenes early in January.

Some time ago there was established in the New York Metropolitan area the Concrete Industry Board whose principal purpose is to improve the quality of concrete. Unique plans for accomplishing this desirable objective are now well under way. Roger H. Corbetta, Chairman of the Concrete Industry Board, and President of the Corbetta Construction Company of New York, will address us on this interesting and important subject.

The Tuesday morning session will be concluded with a feature address entitled "Crises Still Make Our Foreign Policy." With the United States inescapably involved in world affairs, this subject becomes increasingly important. Our speaker will be William G. Hetherington, news analyst and foreign correspondent for the Newark News. Mr. Hetherington is a top-flight foreign correspondent, intimately acquainted with Europe and the Middle-East. As a story teller par excellence, his observations should prove both entertaining and informative, so be sure to hear this distinguished reporter who has made many noteworthy television appearances, including "Meet the Press," "Quizzing the News," "American Forum of the Air," and several others.

The stellar attraction for salesmen will be presented on Wednesday morning following brief reports by the Chairmen of several important NCSA Committees.

"Selling Against Resistance" will be presented in humorous and dramatic form by that incomparable team of sales analysts, Richard C. Borden, and Alvin C. Busse. Through their unique ability to dramatize, humorize, and humanize sales techniques, they demonstrate in a highly entertaining manner, sound sales principles. No one attending this Cincinnati meeting can afford to miss this program feature.

At the General Luncheon on Wednesday, winners of the NCSA Safety Contest will be accorded public recognition for their outstanding achievements in going through the contest year without a lost time accident. The Explosive Engineer Award will be presented to the winner, and certificates of honorable mention also provided through the courtesy of the Explosives Engineer will be awarded each plant making a perfect record. Officiating at the presentation ceremony will be J. J. Forbes, Director of the United States Bureau of Mines, under whose auspices the contest is conducted.

The luncheon address will be made by the Honorable Harold Caldwell Kessinger. It is said that Judge Kessinger is the greatest combination of humorist and orator on the American platform. Speaking on the subject "The Sunny Side of Main Street," his droll humor and homely philosophy, are certain to be highly entertaining.

In view of the increasing tonnages of crushed stone which are going into asphaltic types of highway construction, crushed stone producers should be very much interested in the activities of the Asphalt Institute. This organization has taken two significant steps during the past year, looking towards the expansion of its work, particularly with regard to a stepped up research and development program. On July 1, 1954, J. E. Buchanan, formerly President of

(Continued on Page 25)

Otho McCarroll Graves
1882-1954

OTHO M. GRAVES has journeyed into that land from which no traveler returns. Deeply shocked and saddened by his sudden and unexpected death, the National Crushed Stone Association and his host of friends throughout the crushed stone industry have lost a most valued friend and counselor. Over the past thirty years his gracious yet forceful personality and far-sighted vision gave strength and effectiveness to the crushed stone industry of the United States. His accomplishments in behalf of the industry and its Association, which he loved so well, will be his enduring monument.

His most important contribution outside his own company was to the industry of which he was a part. His early efforts did much to effectuate and promote the solidarity of crushed stone producers and to give substance and dignity to the crushed stone industry.

He served as President of the National Crushed Stone Association for four years, 1925-1928, an honor of unusual distinction. It was during his administration, and largely through his efforts, that in 1925 the Bureau of Engineering was created and the headquarters of the Association was moved to Washington, D. C., followed in 1928 by the establishment of a research laboratory. In 1926 he was granted leave of absence from his company for several weeks to tour the country in the interest of obtaining wider financial support for the Association and its activities.

After retiring as President, his interest in the Association continued to increase rather than diminish. During his long career of active participation in Association affairs he gave generously of his time and talents, serving on many important Association policy committees. Especially noteworthy is the outstanding contribution he made over the years to the success of the annual conventions as Chairman of the Convention Arrangements Committee.

As a member of the Board of Directors and the Executive Committee, he never wavered in the belief that the aims and ambitions of the Association could be realized, and it was through his faithful, loyal, and constant efforts that so much has become a reality.

The crushed stone industry is deeply indebted to Otho Graves for the many years of sacrifice and devotion which he gave so unselfishly in its behalf. It is with a deep sense of grief in our hearts that the National Crushed Stone Association records the passing of a man whose accomplishments will remain a lasting tribute to his memory.

The Stone Industry—A Fifty-Year Review

By J. R. THOENEN

Chief, Mineral Industry Division
Region VII, Bureau of Mines
U. S. Department of the Interior
Knoxville, Tenn.

THE title of this article will induce various pictures in the reader's mind, depending upon which branch of the stone industry interests him.

There are various ways in which the industry may be and has been classified—by kinds of stone such as granite (including all igneous rocks), marble, limestone, sandstone, and miscellaneous; by type or condition, such as cut or dimension stone versus crushed and broken stone; or by uses, such as monumental, building, aggregate, chemical, metallurgical, ballast, and many others.

For the purpose of this article, the type classification is used, namely, crushed and broken stone as distinguished from stone cut to accurate or semiaccurate dimensions for monumental or building purposes. Rubble has been grouped with dimension stone in statistical records, but, as some of the stone so classified is produced by crushed stone operators, it is included here. A considerable tonnage of crushed stone is used in the manufacture of cement and lime, but since this does not enter the market as stone it is excluded from the author's crushed and broken classification.

At the beginning of the century records of stone production were kept on the basis of value at the quarry without recording the tonnage produced. An exception is furnace flux, for which tonnage records are available as far back as 1902. In 1900 the total recorded value of stone production was, in round numbers, $37,000,000, of which $21,500,000 represented cut or dimension stone and $15,500,000 crushed and broken stone. In 1950 the total value had increased over tenfold to $391,000,000; however, roughly $58,000,000 represented dimension stone and $333,000,000 crushed and broken stone.

The classification "crushed and broken stone" has emerged from a minor component of the stone industry in 1900 to nearly six times the value of dimension stone in 1950 (Figure 1). A similar comparison based on tonnage produced shows an even wider divergence (Figure 2).

This article deals with a vital and growing industry exceeded, in tonnage produced, only by crude petroleum, bituminous coal, and sand and gravel industries.

History: Distribution and Organization

The beginning of the stone industry is lost in antiquity, actually predating written history by thousands of years, as evidenced by Stone Age artifacts authenticated by archeologists.

The introduction of lime and Roman cement enabled man to utilize stone to better advantage in the construction of shelters. This marked the emergence of the dimension stone industry. Later, the discovery of portland cement permitted the use of irregularly shaped stone particles in concrete. Dimension stone for building purposes was largely displaced by portland cement and suitable concrete aggregates.

The invention of the automobile and the consequent public demand for better highways was an added incentive to the increased use of concrete and crushed stone.

The fact that stone has been produced in all of the 48 states illustrates the widespread distribution of the industry.

The year-by-year growth of the industry is illustrated in Figure 1. Total values are shown for stone produced since 1900, but figures for total tonnages are available only since 1916.

Table I shows the widespread distribution of the industry among the several states and territories for the years 1949 and 1950; these figures include dimension stone. Table II gives the distribution by size of plant (exclusive of noncommercial producers) for 1941 and 1950.

An appreciable tonnage of stone is produced by noncommercial producers, as governmental agencies producing on their own account or through contractual relations with others. Figure 3 shows the relative production by commercial and noncommercial producers since 1935.

In Table III the production of crushed and broken stone has been broken down to show the quantities produced for various uses in 1926 and 1950 for comparison.

Figure 4 shows the value of crushed and broken stone produced since 1900 and the tonnage produced since 1916.

TABLE I

STONE PRODUCTION IN THE UNITED STATES, 1949–50

State	1949		1950	
	Short Tons	Value	Short Tons	Value
Alabama	2,636,930	$6,039,867	2,587,500	$6,038,220
Arizona	356,050	203,295	228,490	139,810
Arkansas	[1] 1,279,250	[1] 2,247,236	3,952,720	7,419,110
California	11,373,700	12,594,048	11,764,630	13,998,432
Colorado	[1] 1,816,790	[1] 2,803,538	[1] 1,679,960	[1] 2,776,331
Connecticut	1,695,650	2,460,547	[1] 1,860,700	[1] 2,789,532
Delaware	37,240	92,100	77,050	190,113
Florida	4,215,090	4,748,253	5,313,400	6,885,394
Georgia	[1] 4,156,220	[1] 8,427,627	[1] 6,144,980	[1] 11,917,482
Idaho	1,440,680	1,878,801	[1] 644,020	[1] 861,290
Illinois	17,054,110	20,682,162	17,911,480	21,970,537
Indiana	[1] 6,332,360	[1] 15,227,818	6,994,670	20,686,160
Iowa	6,831,190	8,663,201	[1] 8,425,490	[1] 10,668,427
Kansas	[1] 5,978,420	[1] 7,951,490	7,630,300	8,920,207
Kentucky	7,100,160	8,586,402	[1] 7,417,200	[1] 8,865,913
Louisiana	[2]	[2]	[2]	[2]
Maine	258,810	2,025,870	[1] 309,740	[1] 2,214,164
Maryland	[1] 1,789,830	[1] 3,036,410	1,975,690	3,459,605
Massachusetts	2,290,940	6,552,935	[1] 3,284,470	[1] 8,484,999
Michigan	16,546,670	13,387,334	19,095,540	15,391,366
Minnesota	1,878,910	5,278,716	[1] 1,953,450	[1] 5,334,028
Mississippi	[2]	[2]	100,000	115,000
Missouri	9,562,720	13,969,008	10,300,400	14,406,627
Montana	[1] 602,890	[1] 563,465	919,090	949,545
Nebraska	[1] 504,870	[1] 840,758	[1] 736,660	[1] 1,042,035
Nevada	518,510	668,960	[1] 274,460	[1] 269,478
New Hampshire	6,910	381,141	[1] 15,760	[1] 383,667
New Jersey	4,070,790	7,896,619	[1] 4,672,050	[1] 9,119,251
New Mexico	138,290	106,135	364,930	243,841
New York	13,022,070	18,160,387	13,121,850	19,728,957
North Carolina	6,225,290	10,077,976	7,711,580	11,894,745
North Dakota	[2]	[2]	193,250	135,698
Ohio	[1] 19,364,230	[1] 27,419,158	20,466,350	28,628,678
Oklahoma	4,341,930	4,027,409	5,021,660	4,848,223
Oregon	[1] 4,397,390	[1] 6,479,164	[1] 3,836,550	[1] 5,559,010
Pennsylvania	21,226,480	34,855,664	25,493,230	42,205,691
Rhode Island	[1] 74,670	[1] 451,029	239,400	798,186
South Carolina	2,440,540	[1] 3,628,596	[1] 2,557,510	[1] 3,836,056
South Dakota	[1] 1,023,710	[1] 4,473,432	[1] 1,205,910	[1] 4,860,858
Tennessee	[1] 7,613,530	[1] 13,026,948	7,978,590	13,802,288
Texas	4,158,430	5,289,647	[1] 4,893,150	[1] 5,580,463
Utah	283,020	427,418	929,410	880,667
Vermont	441,770	8,276,287	447,310	8,038,892
Virginia	7,509,740	12,442,765	9,272,740	16,434,602
Washington	[1] 3,688,890	[1] 4,105,516	4,930,820	5,734,563
West Virginia	4,854,590	6,960,191	[1] 5,367,510	[1] 7,825,653
Wisconsin	7,326,710	13,636,020	6,999,630	14,494,750
Wyoming	1,802,580	2,227,096	1,841,400	2,214,037
Undistributed	2,279,200	6,163,877	1,701,560	4,867,957
Total	222,548,750	339,442,316	250,844,240	387,910,538
Alaska, Hawaii, Puerto Rico	1,477,820	1,999,329	1,268,810	2,671,559
Grand Total	224,026,570	341,441,645	252,113,050	390,582,097

[1] To avoid disclosing confidential information certain state totals are incomplete, the portion not included being combined with "Undistributed"

[2] Included with "Undistributed"

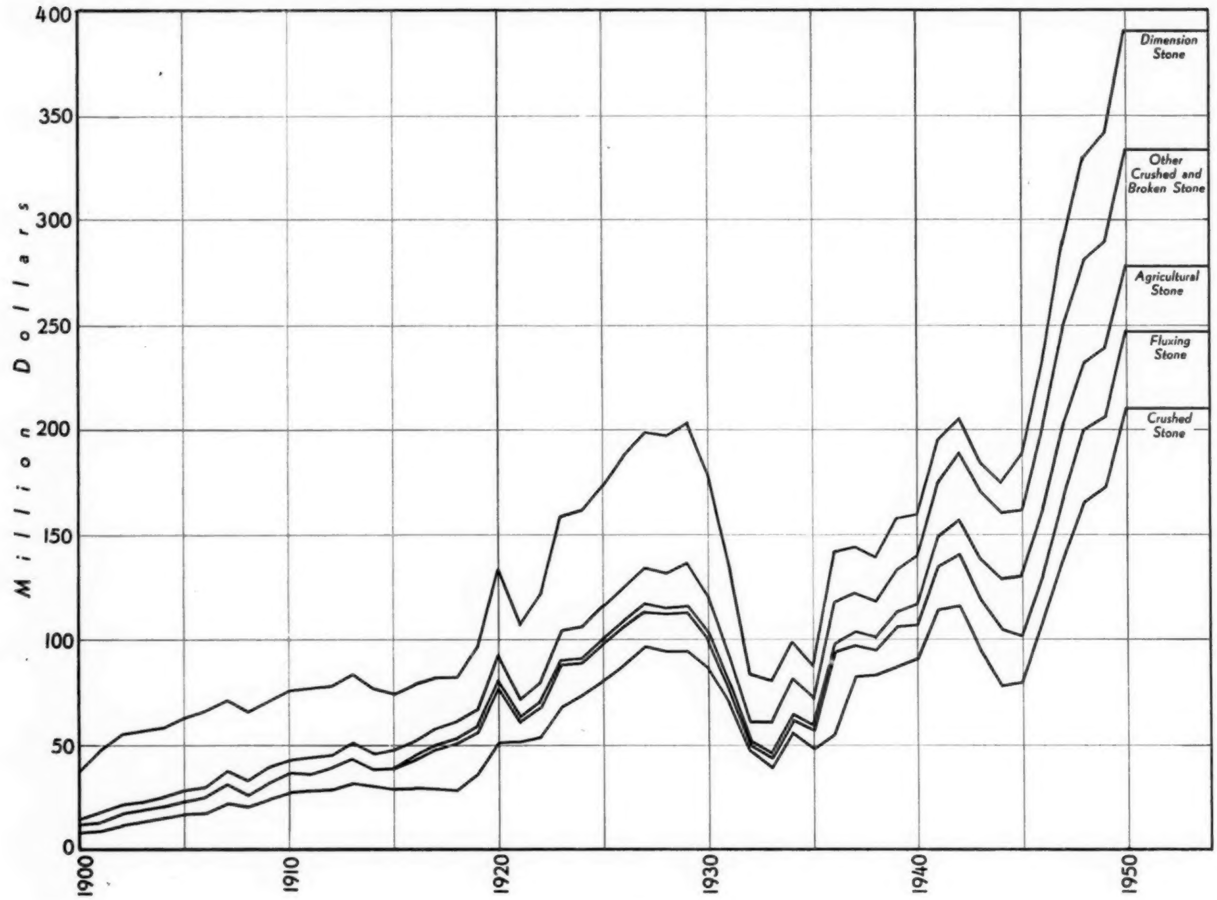

FIGURE 1
Value of Stone Production, by Uses

Figures 1 to 4 and Tables I to III have been presented to emphasize the wide geographic distribution of the industry, the range in capacity of producing plants, the variety of uses for which crushed and broken stone is produced, and the development of the industry.

Geology

Since the beginning of the study of rocks, geologists and mineralogists have recognized that rocks forming the crust of the earth can be divided into two great, sharply contrasted groups, namely, "igneous" and "sedimentary." To these has been added a third group, the rocks of which may exhibit characteristics of both the other groups. The third group is termed "metamorphic."

The first rock formations to appear were igneous. These solidified by cooling from molten magmas. As they solidified or froze they were subjected to the disintegrating effect of expansive and contractive phenomena caused by alternating degrees of heat and cold, penetration of moisture through incipient or open cracks, direct solution of the contained minerals, or combinations of these agents.

The disintegrated particles carried by streams or rivers to lakes or ocean bottoms were deposited as separate particles or chemical precipitates. Under pressure of sea water and overlying solids, and/or cementation from chemical action, the loose particles were indurated to form the strata of sedimentary rocks.

Subsequent mountain building forces within the

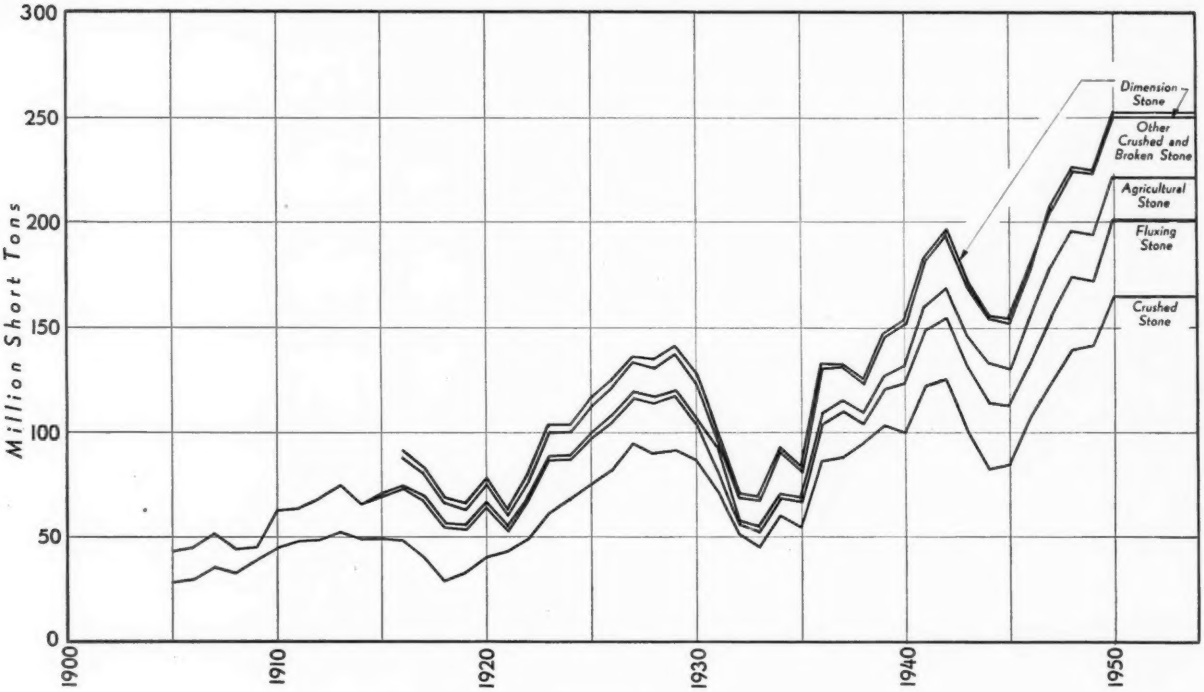

FIGURE 2
Production of Stone, by Uses

TABLE II
COMPARISON OF NUMBER AND PRODUCTION OF COMMERCIAL CRUSHED-STONE PLANTS IN THE UNITED STATES, 1941–50, BY SIZE GROUPS

Size Group, Annual Production, Short Tons	1941 [1]						1950 [2]					
	Plants			Production			Plants			Production		
	Number	Per cent of Total	Cumulative Per cent	Tons	Per cent of Total	Cumulative Per cent	Number	Per cent of Total	Cumulative Per cent	Tons	Per cent of Total	Cumulative Per cent
Less than 1,000	141	8.1	8.1	99,460	.07	.07	49	3.0	3.0	22,950	.01	.01
1,000–25,000	805	46.4	54.5	7,639,860	5.34	5.41	471	29.1	32.1	5,044,040	2.20	2.21
25,000–50,000	254	14.7	69.2	8,893,690	6.22	11.63	251	15.5	47.6	9,190,720	4.03	6.24
50,000–75,000	141	8.1	77.3	8,655,220	6.05	17.68	185	11.4	59.0	11,387,660	4.97	11.21
75,000–100,000	82	4.7	82.0	7,125,430	4.97	22.65	140	8.6	67.6	12,058,880	5.26	16.47
100,000–200,000	147	8.5	90.5	21,549,890	15.07	37.72	236	14.6	82.2	33,563,530	14.66	31.13
200,000–300,000	58	3.3	93.8	14,235,700	9.95	47.67	103	6.4	88.6	25,020,380	10.92	42.05
300,000–400,000	39	2.2	96.0	13,556,340	9.47	57.14	72	4.4	93.0	24,903,960	10.88	52.93
400,000–500,000	29	1.7	97.7	13,139,480	9.18	66.32	31	1.9	94.9	13,852,520	6.05	58.98
500,000–600,000	7	.4	98.1	3,850,070	2.68	69.00	15	.9	95.8	8,346,320	3.64	62.62
600,000–700,000	5	.3	98.4	3,243,550	2.27	71.27	15	.9	96.7	9,593,000	4.19	66.81
700,000–800,000	6	.3	98.7	4,494,440	3.14	74.41	12	.7	97.4	9,042,710	3.95	70.76
800,000–900,000	4	.2	98.9	3,367,900	2.35	76.76	10	.6	98.0	8,753,870	3.82	74.58
900,000 and over	19	1.1	100.0	33,186,870	23.24	100.00	32	2.0	100.0	58,208,790	25.42	100.00
	1,737	100.0	....	143,037,900	100.00	....	1,622	100.0	....	228,989,330	100.00	....

[1] Average annual production per plant, 82,300
[2] Average annual production per plant, 141,200

TABLE III

CRUSHED AND BROKEN STONE PRODUCED IN THE UNITED STATES
1926 AND 1950, BY PRINCIPAL USES

Use	1926			1950			Change in Unit Value, per cent
	Thousand Short Tons	Value		Thousand Short Tons	Value		
		Thousand Dollars	Per Ton		Thousand Dollars	Per Ton	
Concrete and road metal	66,893	74,920	$1.12	147,108	192,294	$1.31	+ 17
Railroad ballast	15,623	12,811	.82	18,614	17,520	.94	+ 15
Metallurgical	23,859	18,133	.76	35,970	37,932	1.05	+ 38
Alkali works	3,556	2,347	.66	6,174	5,870	.95	+ 44
Riprap	4,060	4,669	1.15	6,898	7,807	1.13	− 2
Rubble	539	917	1.70	247	615	2.49	+ 46
Agricultural	1,851	3,072	1.66	19,349	30,393	1.57	− 5
Refractory	1,531	1,914	1.25	2,158	5,849	2.71	+ 117
Asphalt filler	416	1,414	3.40	750	2,778	3.70	+ 9
Calcium carbide	357	236	.66	750	783	1.04	+ 58
Sugar factories				718	1,608	2.24	
Glass factories				770	1,721	2.24	
Paper mills				432	942	2.18	
Other uses	2,063	4,972	2.41	10,563	26,621	2.52	+ 5
Total	120,748	125,405	1.04	250,501	332,733	1.33	+ 28
Cement manufacture	41,974			59,361			
Lime manufacture	9,121			14,980			

earth caused displacement of sea and land masses. These movements set up enormous stresses which crushed the minerals of igneous and sedimentary rocks and, in some instances, stretched them out in bands and layers resembling the beds or strata of sedimentaries. The intense heat of igneous intrusions through or parallel with sedimentary strata so altered the latter near the contact that it is often difficult to distinguish them from the intrusive. Again, sedimentary rocks buried to great depths beneath igneous flows and subjected to consequent pressure and heat in the presence of migrating moisture became crystallized into new chemical combinations. Thus, the third group or metamorphic rock was formed.

The Bureau of Mines statistical reports classify rocks (or stone) as granite, basalt (or related rocks), marble, limestone, sandstone, and other stone. These subdivisions are not strictly in accord with geologic or mineralogic data but rather represent rough commercial classifications based largely on early dimension stone usage.

Table IV shows the value of production by kinds of stone for 1900 and 1950. These figures include all types of stone, as dimension, crushed and broken, etc.

Although the production of granite and sandstone has increased fourfold or more, each has decreased percentagewise. Whereas marble has decreased two-thirds and other stone has little more than held its own, limestone has increased from 47 to 65 per cent of total production.

Mining

Two general processes are used in mining crushed and broken stone—open quarry and underground mining. Each of these methods can be further divided into a number of subdivisions. Thus, underground stone mines may be entered by adits (tunnels) or by inclined or vertical shafts. Mining may be by room and pillar, shrinkage stoping, underhand stoping, glory hole, or sublevel stoping. Open quarries may be entered on the level or through rising or declining slopes. Their operation is similar except that one may be on level ground, another on a hillside, and the third below the surrounding land surface.

Underground

Underground mining requires most, if not all, of the tools and methods used by the mining engineer in recovering metallic ores or nonmetallic minerals from underground deposits. In fact, the under-

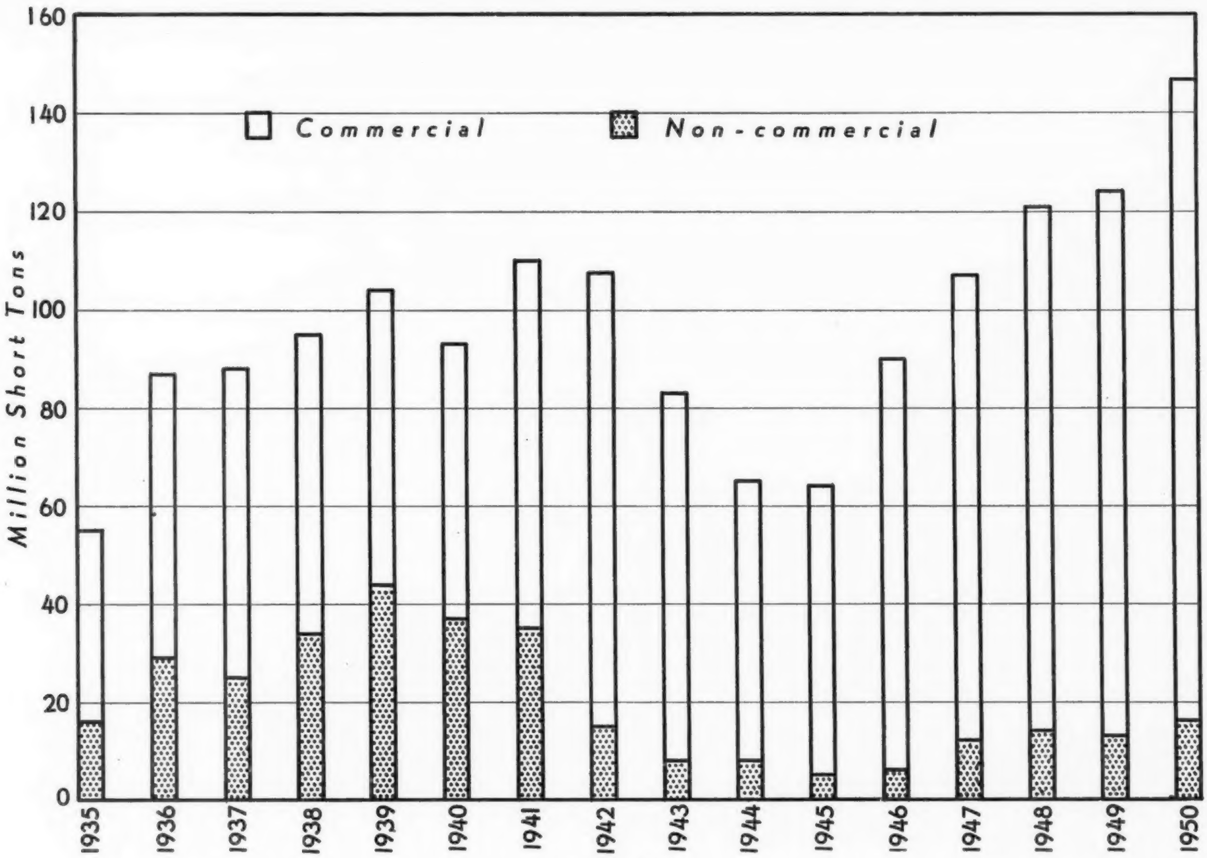

FIGURE 3

Crushed Stone for Concrete and Road Metal Sold or Used by Commercial and Non-commercial Operators in the United States

ground quarryman has adapted for his use many of the mining methods developed and perfected for metallic mines. In addition, he has developed methods of his own and applied them advantageously.

The first underground mine opened in the United States for the mining of stone was that of the Lowmoor Iron Co., at Lowmoor, Va., in 1883.[1] Bulletin 262 also gives the underground production of limestone as compared with that from open quarries for 1900 as 105,000 short tons compared with 5,838,000 short tons in 1924. The underground production was 0.3 per cent in 1900 and 4.5 per cent in 1924. In 1948 the underground production of limestone had increased to 14,600,000 short tons, or nearly 9 per cent of the total limestone production. Comparative figures for later years are not available.

[1] Thoenen, J. R., Underground Limestone Mining; Bureau of Mines Bulletin 262, 1926

The underground mining of crushed and broken stone has been confined almost entirely to limestone. However, marble for dimension stone is being mined underground, and sandstone is being mined for silica.

Many underground stone mines were started by driving into the sides of open quarries when the expense of overburden removal had become too great. On the other hand, a number of these operations were initiated by sinking inclined or vertical shafts to reach deep-seated limestone beds.

Open Quarries

Surface quarry operations in general follow the same pattern as at the beginning of the century in that they are horizontally advanced faces opened

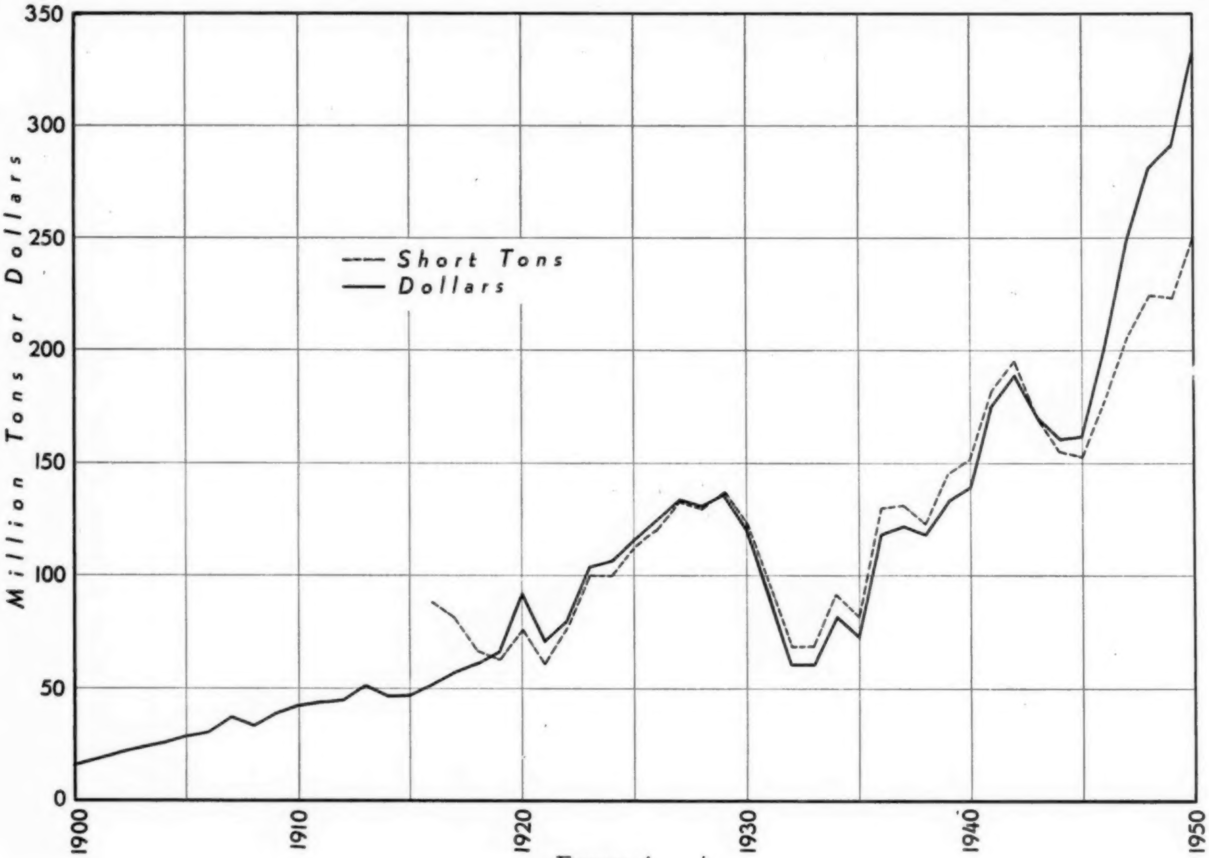

FIGURE 4
Production and Value of Crushed and Broken Stone

in a hillside or below the level of the surrounding surface.

Details of operation, however, have altered tremendously. The early steam shovel and light railway for removing overburden have given way to internal combustion or electric powered shovels mounted on caterpillar traction and to motor trucks. In some instances, self-propelled carryalls do the entire job.

Quarry piston drills mounted on tripods have been replaced by high speed wagon-mounted hammer drills. Churn drills are finding competition with large hammer drills or self-propelled rotary drills.

Blasting methods have changed with the knowledge gained by study of the effect of quarry vibrations on adjacent buildings. This study was initiated by the Bureau of Mines[2] but has been greatly intensified by industry research. As a result of this research, millisecond delay blasting of quarry shots

[2] Thoenen, J. R., and Windes, S. L., Seismic Effects of Quarry Blasting; Bureau of Mines Bulletin 442, 1942

TABLE IV
VALUE OF STONE PRODUCED, BY KINDS, IN THOUSANDS OF DOLLARS

Year	Granite	Basalt	Marble	Sandstone	Limestone	Other	Total
1900	$10,969	$ 1,706	$ 4,267	$ 5,273	$ 20,354	$ 1,198	$ 43,767
1950	52,221	34,373	10,932	23,787	252,756	16,514	390,582

has reduced vibration and permitted operation of many quarries that otherwise would have been closed by litigation as a public nuisance. Millisecond delay blasting has been effective also in reducing the need for secondary blasting of oversize material produced in primary shooting.

Quarry haulage to the crushing and screening plant has been modernized by substituting autotrucks for horse and wagon or light railway haulage.

Milling

The average stone producer does not consider his mining problem distinct from his milling problem, as does the operator of a metal mine. The "mining" and "milling" of stone are merely component parts of a single operation. Nevertheless, the ore dresser can learn much by studying the modern stone crushing and screening plant.

The present design of crushing equipment was developed largely by manufacturers working with stone producers. The same thing is true of the design of screening equipment.

Early in the century much of the stone was marketed as "quarry run"; today it has to be screened to specific sizes, with designated top and bottom limits, or in various combinations of sizes, each with its top and bottom limits and the whole within rather strict fineness modulus limitations. Moreover, many specifications require definite limits on so-called flat or elongated particles.

The multiplicity of specifications which the established stationary plant has had to meet to satisfy design engineers has forced many operators to stockpile specific sizes and reclaim and blend them percentagewise to meet the various combinations required.

As markets for crushed stone, particularly in the construction of highways, have extended beyond the normal reach of established quarry operations, highway contractors have demanded and equipment manufacturers have designed and built portable crushing and screening plants of various capacities. These plants are well suited to small quarries in that they can be adjusted to produce stone that will meet the specifications of a particular job and when that job has been completed can be moved to another quarry, and by fairly simple changes made suitable for supplying material that will meet another set of specifications.

Byproducts

In the early days the operator of a limestone quarry sent to waste piles most, if not all, of his production that passed a 1/2 in. screen. Today a large part of this material, plus much more purposely reduced to this size, is marketed as agricultural limestone. Agricultural limestone may therefore be considered a byproduct of the crushed and broken stone industry.

In late years there has been an increasing demand for artificial sand made by crushing, grinding, sizing, and reblending various sizes into a material to be used in place of natural sand as a fine aggregate.

Some producers are even seriously considering the recovery of heavy minerals from their very fine waste sludges.

Substitutes

Sand and gravel and crushed slag are active competitors of crushed and broken stone. Pumice is occasionally used as a coarse aggregate where light weight or high temperature resistance is a requisite.

Substitute coarse and fine aggregates have been successfully prepared from calcined clay or shale.

Where light weight is a requisite, a rather wide choice of expanded materials is available for both coarse and fine aggregate.

Tailings from ore dressing operations and slag from smelters and blast furnaces are common sources of both coarse and fine aggregate. A number of large metal mines process waste tailings for lucrative sale in the aggregate market.

It would be interesting to know what effect the use of competitive and substitute materials has had on the crushed stone market; however, production figures are not sufficiently complete to permit of this determination.

Table V shows the production and value of crushed stone, sand, gravel, and slag for concrete and road metal and railway ballast for 1938 and 1950.

A study of the table shows an increase of each item in 1950 over the corresponding item in 1938, as could be expected. However, this one point is the only parallelism. For example, total material for both uses increased from 274 to 530 million tons, or 93 per cent. Compared on this basis, crushed stone and gravel lagged behind, with increases of 74 and 85 per cent, respectively, whereas sand and slag increased 142 and 156 per cent, respectively. A similar variation may be noted in the use for con-

TABLE V

COMPARISON OF MAJOR CONSTITUENTS USED IN CONCRETE AGGREGATE, ROAD METAL, AND RAILWAY BALLAST

(Thousands of Tons and Thousands of Dollars)

Type	Concrete and Road Metal		Railway Ballast		Total	
	Short Tons	Value	Short Tons	Value	Short Tons	Value
1938:						
Stone	88,787	$84,212	5,976	$4,555	94,763	$88,767
Sand	48,476	24,541	786	213	49,262	24,754
Gravel	114,975	49,318	8,194	2,255	123,169	51,573
Slag	5,484	5,105	1,510	796	6,994	5,901
Total	257,722	163,176	16,466	7,818	274,188	170,995
1950:						
Stone	145,984	189,867	18,609	17,513	164,593	207,380
Sand	118,285	91,230	902	424	119,187	91,654
Gravel	218,870	161,177	9,451	5,249	228,321	166,426
Slag	13,484	17,666	4,435	3,967	17,919	21,633
Total	496,623	459,940	33,397	27,153	530,020	487,093

crete and road metal—crushed stone registered a gain of 64 per cent, gravel 90 per cent, and sand and slag 144 and 146 per cent, respectively.

For use as railway ballast, however, crushed stone increased 211 per cent compared to 194 per cent for slag and 15 per cent each for sand and gravel.

A comparison of the unit values per ton shows that the average for all constituents and all uses rose from 62 cents in 1938 to 92 cents in 1950, or 48 per cent. During the same period the unit value for crushed stone used in concrete and road metal gained 37 per cent, slag 41 per cent, sand 52 per cent, and gravel 72 per cent. For railway ballast the unit value for stone gained 24 per cent, slag 68 per cent, sand 74 per cent, and gravel 102 per cent.

In relative volume, computations from the table will show that stone lost by roughly 5 per cent to sand, gravel, and slag for use as concrete and road metal but gained 19 per cent for use as railway ballast, with a total over-all loss of 3 1/2 per cent.

Reserves

United States reserves of stone suitable for the crushed and broken stone market may be considered nearly limitless only if economic considerations are ignored. The reserves of many local quarries may be quite limited owing to encroachment of housing or for other reasons. The markets for crushed stone are limited economically to relatively short delivery distances, to competitive areas, to areas of construction or repair and maintenance, and by stringent quality requirements. Locally, reserves that meet economic requirements may be quite limited.

Figure 5 shows the relatively high percentage of crushed and broken stone moved by trucks, which suggests the short-haul market range. However, this cannot be considered accurate because considerable quantities of aggregates have been shipped by water from New England quarries to Florida markets.

Uses

Table III shows the widespread uses for which stone is marketed. The item "Other Uses," as shown in the table, could be broken down into a multitude of minor uses, supplied principally by limestone producers.

Production, Consumption, and Foreign Trade

To illustrate the relationship between the crushed and broken stone industry and other industries, Figures 6, 7, and 8 are presented.

Figure 6 shows the close parallelism between the production of pig iron and flux stone and the tonnage of stone used per ton of pig iron.

Figure 7 compares the value of crushed stone production with the cost of road construction. It will be noted that these two graphs cross in 1937 and again in 1947. Also, prior to 1937 the two are not consistently parallel. These graphs indicate that although the crushed stone business has a large

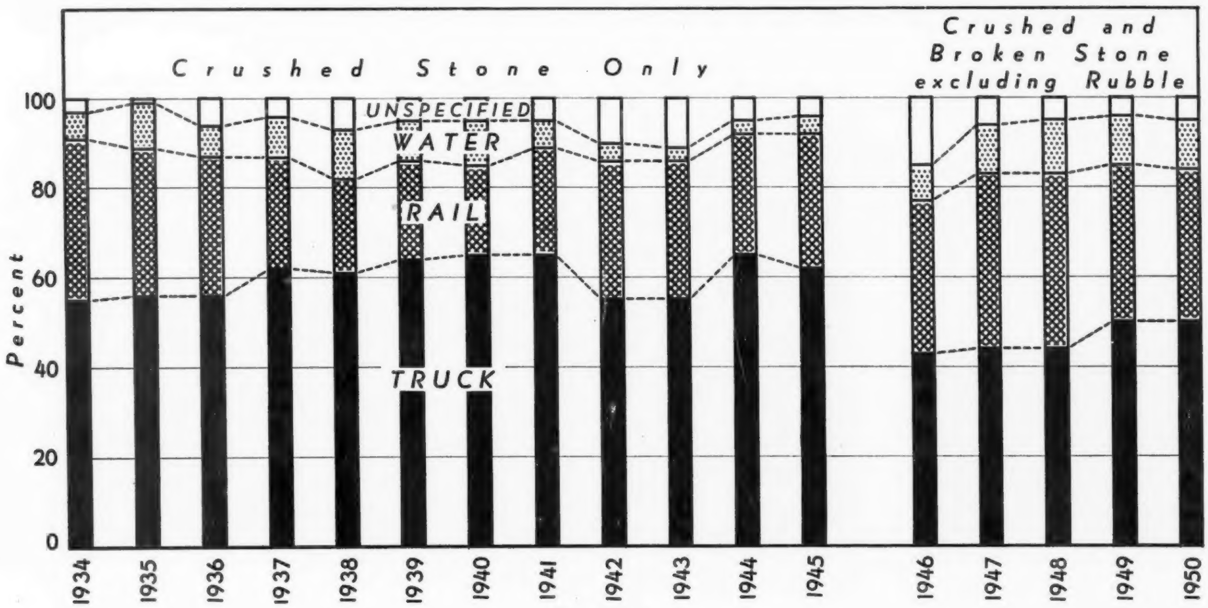

FIGURE 5

Crushed and Broken Stone Movement From Plants of Commercial Producers

stake in the progress of highway construction, it also has other outlets, as illustrated by comparison of the two graphs for the period 1925 to 1930 and the period 1940 to 1945. The interrelationship is again evident by the fact that crushed stone production follows rapidly rising highway expenditures, 1945 to 1950.

Figure 8 shows the parallelism between the value of crushed stone production and that of total construction in the United States.

TABLE VI

STONE IMPORTS, EXCLUSIVE OF MONUMENTAL OR BUILDING

Year	Item	Short Tons	Value	Value Per Ton
1941	"Rough"	58,662	$38,629	$ .49
1942	"	41,455	30,767	.74
1943	"	41,280	31,957	.77
1944	"	46,031	40,590	.88
1945	"	52,567	52,287	1.00
1946	"	33,727	59,316	1.76
1947	"	43,774	81,831	1.88
1948	"	43,590	100,612	2.29
1949	"	52,258	122,417	2.34
1950	"	55,317	124,817	2.26

Table VI presents the tonnage and value of stone imported into the United States, exclusive of monumental or building stone. It is doubtful if these imports materially affect the market for domestic crushed or broken stone. The imported stone is primarily limestone imported from Canada for flux, road base, and riprap.

The exports of stone are negligible.

Prices and Costs

The values of crushed and broken stone for various uses, as given in Table III, are the values at the plant as reported by the producer to the Bureau of Mines. The price the consumer must pay will depend upon the cost of transportation from plant to consumer and the proportion of such delivery expense that the producer is willing to absorb to meet competition or to keep his plant running during a slack period. For these reasons, selling prices may reflect only casual relationship to values at the plant.

It is interesting to compare the plant values per ton for the two years 1926 and 1950 as given in Table III and emphasized by the per cent changes in the last column.

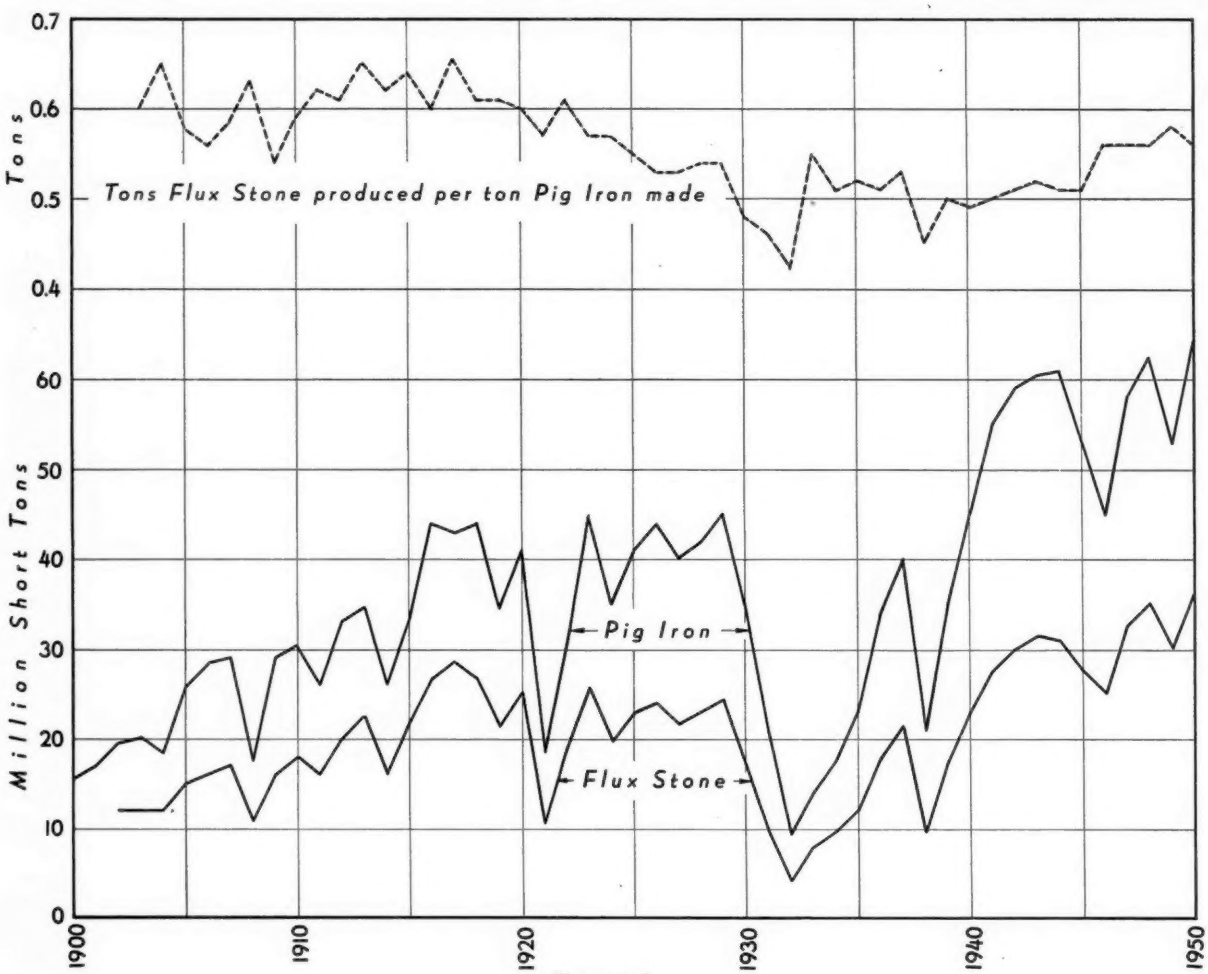

FIGURE 6

Relation of Flux Stone to Pig Iron Production

Of the large tonnage uses, concrete and road metal and railroad ballast have increased only 17 and 15 per cent, respectively, in unit value at plant. Riprap has lost by 2 per cent and agricultural stone by 5 per cent. On the other hand, metallurgical stone (flux) gained 38 per cent, and alkali works and rubble 44 and 46 per cent, respectively. Refractory stone seems to have made the greatest gain (117 per cent).

When one considers that in terms of 1939 values the dollar was worth 79 cents in 1926 and only 56 cents in 1950, it is evident that the plant values in 1950 would have to advance nearly 30 per cent to hold their own. It appears, then, that stone supplied for only five of the uses enumerated has gained in value based on 1939 dollars. Actually, the advance for total stone value was only 28 per cent; hence, there has been no over-all gain based on a constant dollar value in these 25 years.

Conservation

There has been little need for conservation in the stone industries. The supply has been adequate, with the possible exception of those plants located on deposits within or on the edges of growing municipalities. In a sense, conservation has been practiced by some operators so located in that they have procured portable plants and set them up on

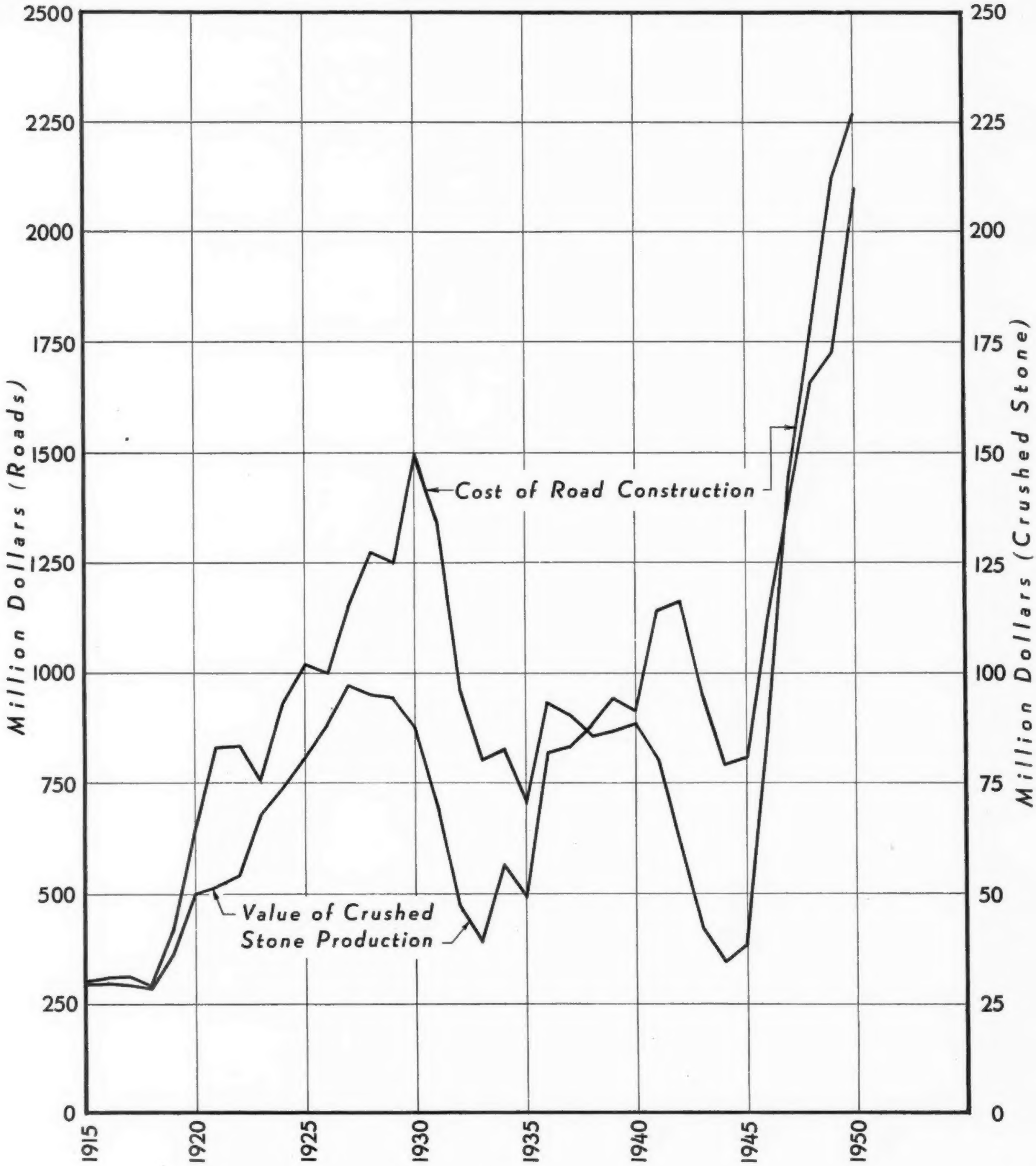

FIGURE 7

Relation of the Value of Crushed Stone Production (Bureau of Mines) to the Cost of Highways, Roads, and Streets (Bureau of Census)

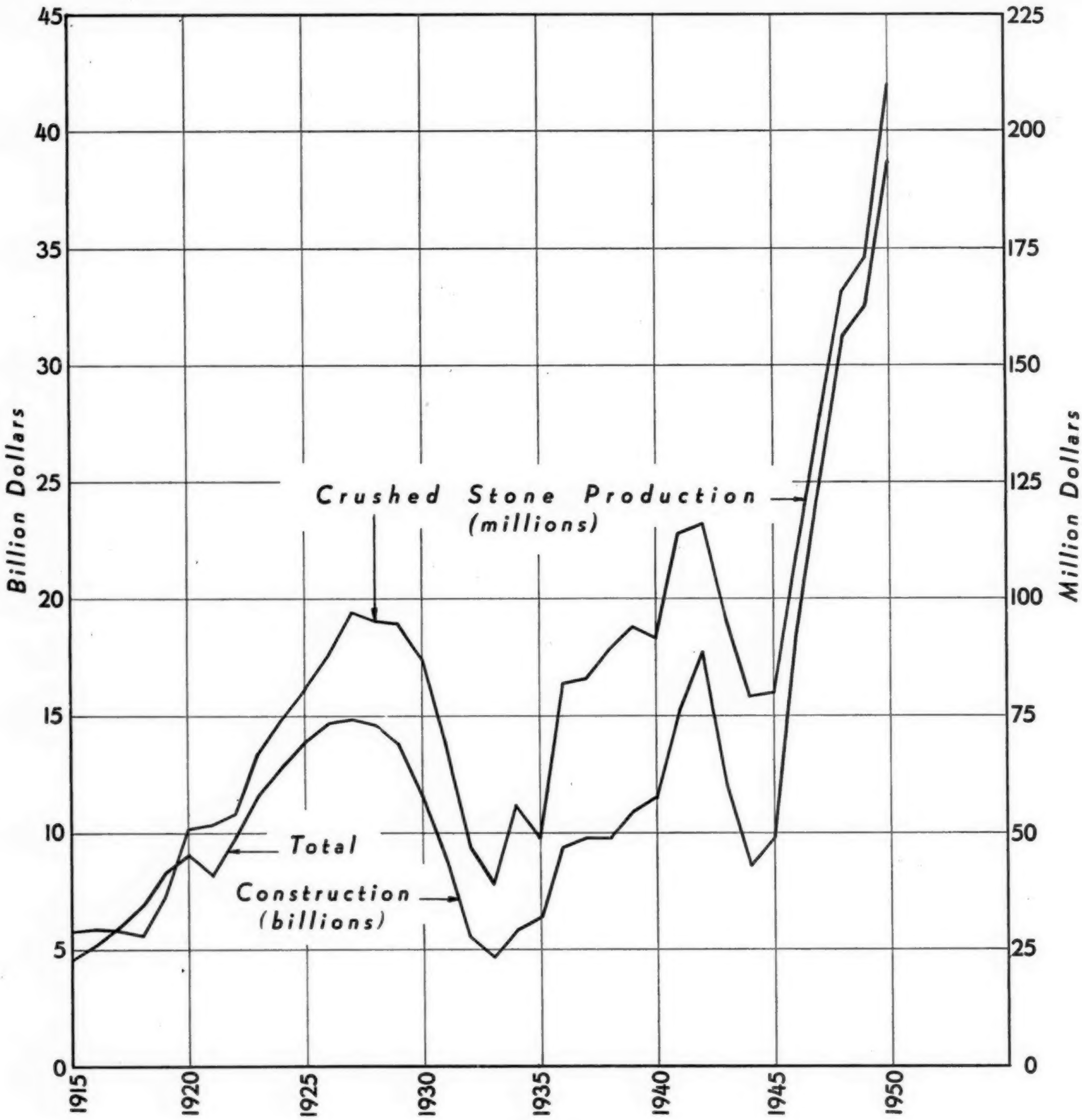

FIGURE 8
Comparison of the Value of Crushed Stone Production in Millions (Bureau of Mines) With Total Value of All Construction in Billions (Bureau of Census)

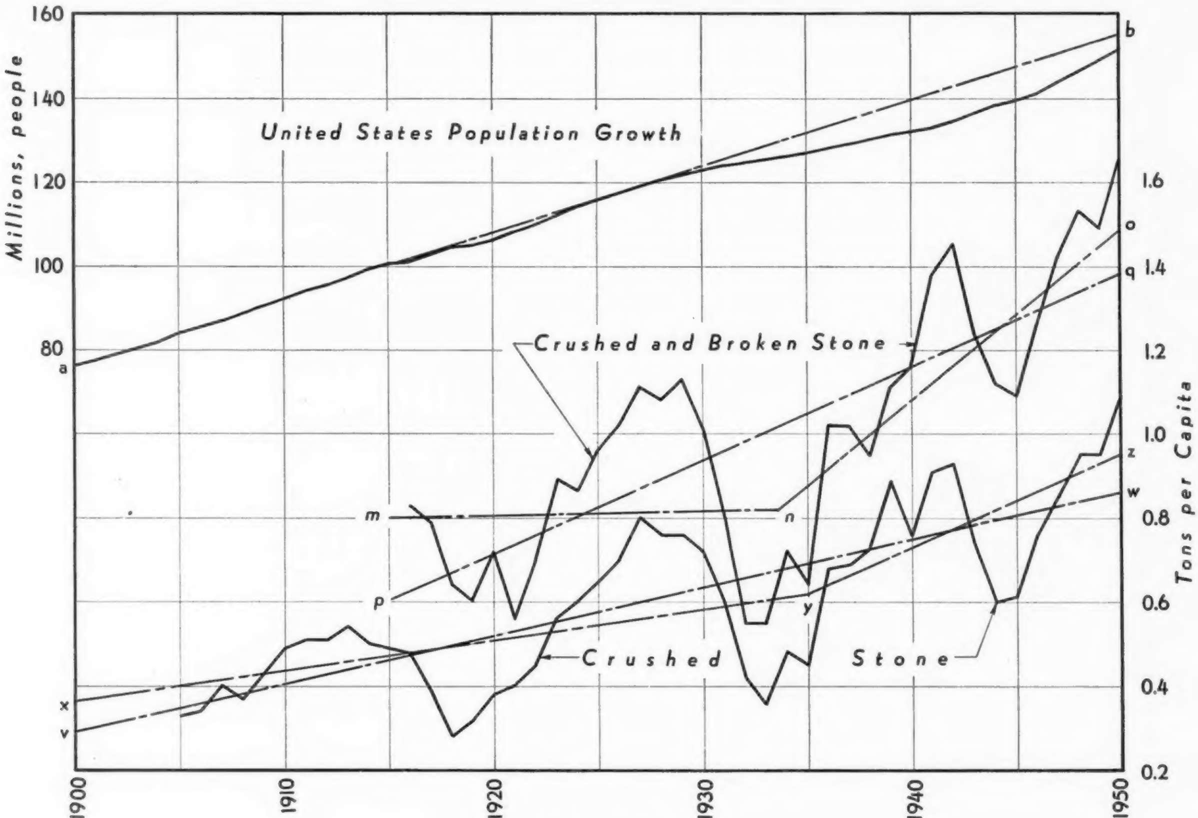

FIGURE 9

Production Per Capita for Crushed and Broken Stone Compared to Population Growth

deposits in the field nearer highway or other contracts that they would otherwise have supplied from their city plant. This could be construed as conservation of the city deposits for city markets.

Significant Trends

Figure 9 compares stone production with population increase. The top curve represents population growth as reported by the Census Bureau. The straight or "trend" line was added by the author. As may be noted, population growth fell below the trend line in 1930, but by 1952 it had recovered.

The middle curve represents the production of crushed and broken stone since 1916 and the bottom curve, the production of crushed stone alone since 1905. Both curves representing crushed and broken stone and crushed stone only are quite erratic from year to year, indicating clearly that population growth alone is not a major prerequisite for expansion of the stone industries.

Dashed lines *pq* and *vw* drawn through these curves represent mathematically calculated trend lines from 1916 to 1950 and 1905 to 1950. As may be noted, the slope of line *pq* is steeper than the slope of line *ab*, the population trend line. On the other hand, the slope of line *vw* is flatter than *ab*. The inference to be drawn here is that the crushed and broken stone industry (line *pq*) during the period 1916 to 1950 has expanded at a greater rate than population. Line *vw*, however, indicates that the crushed stone industry, when considered alone, has not kept pace with population growth.

If these curves are broken into two component parts at 1935 and the trend lines are recalculated, dotted line *mno* is nearly flat from 1916 to 1935 but very steep from 1935 to 1950.

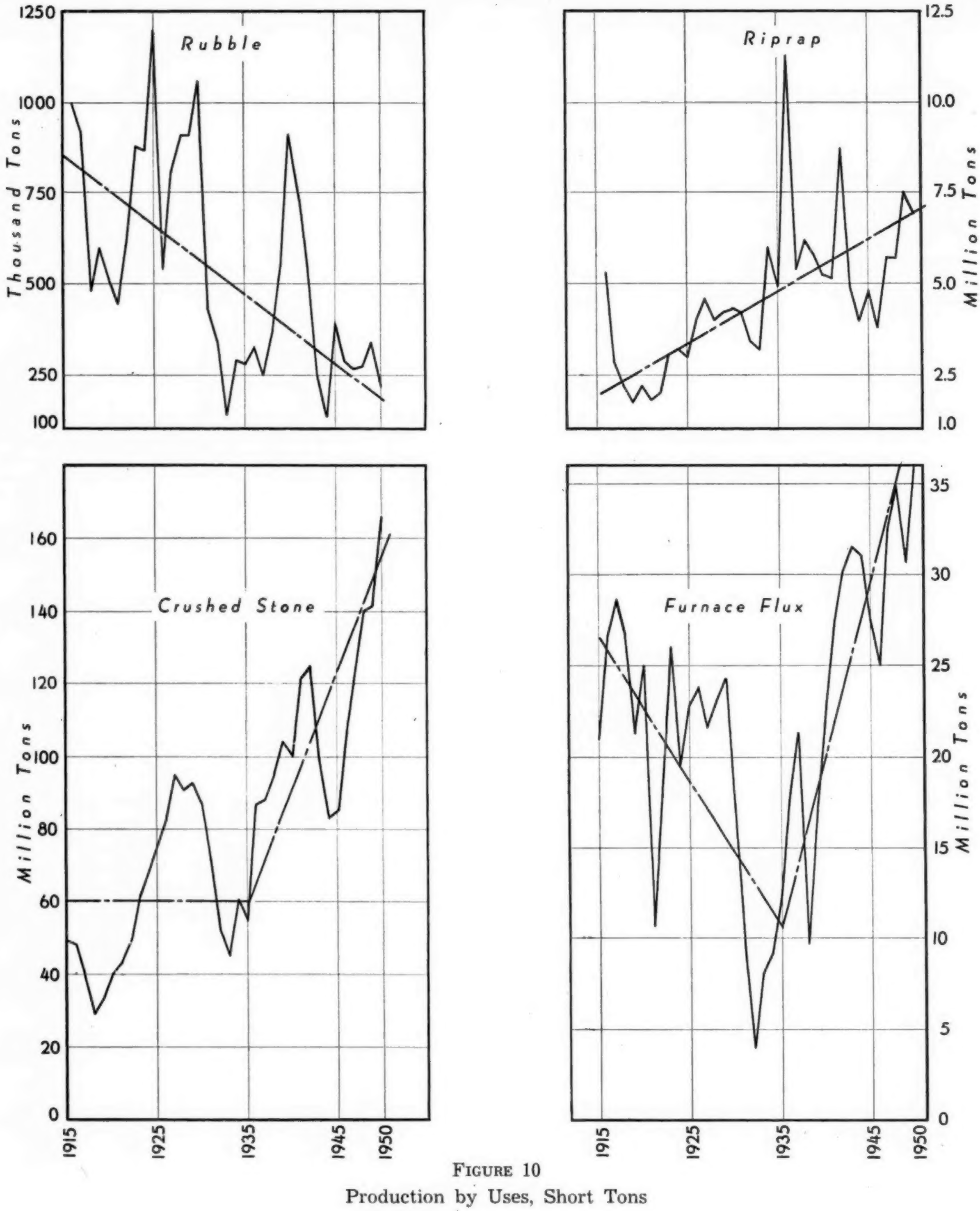

FIGURE 10
Production by Uses, Short Tons

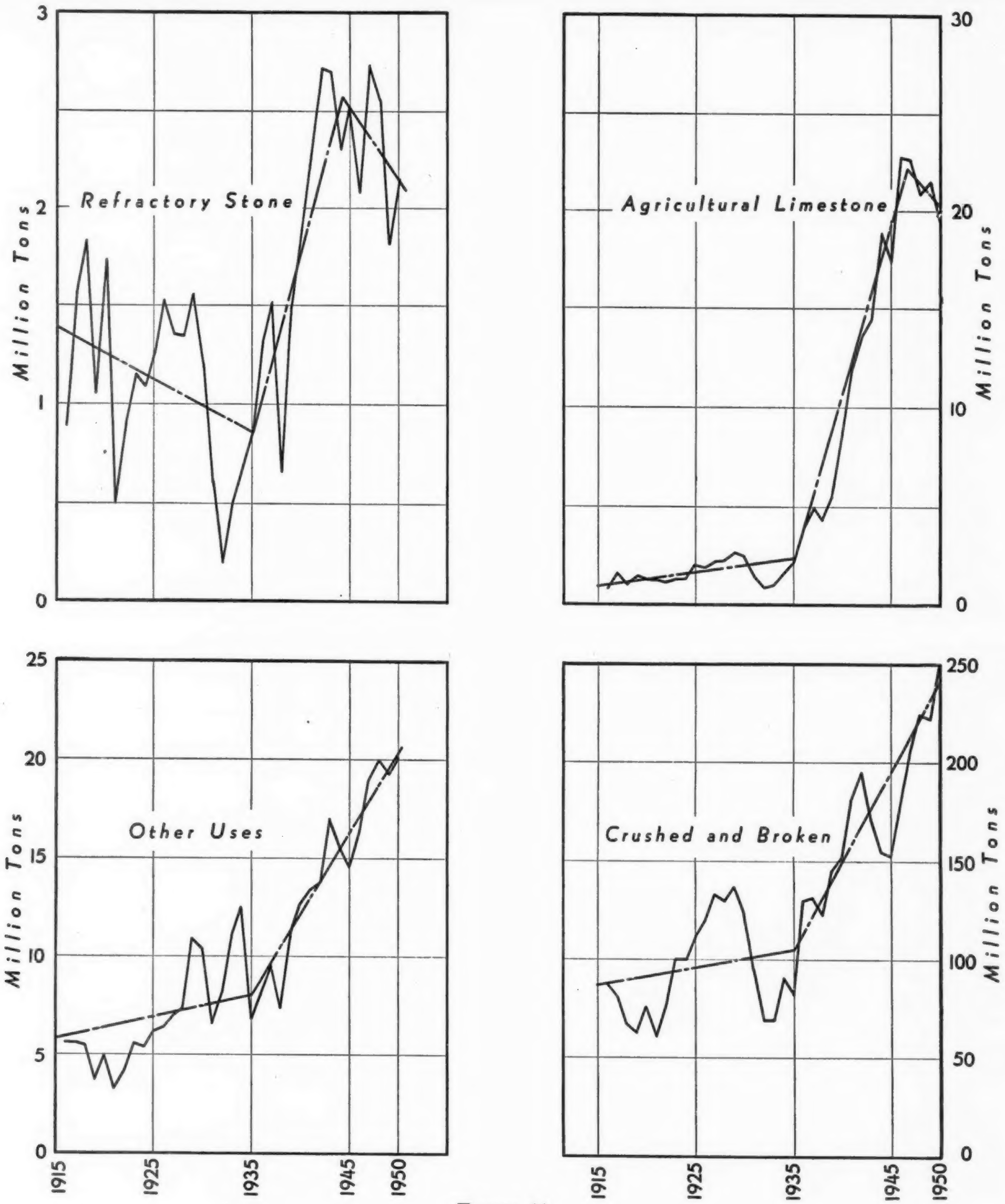

FIGURE 11
Production by Uses, Short Tons

Line *xyz*, representing crushed stone, shows a similar trend, except that this line is not as flat as *mn* from 1905 to 1935 and not as steep as *no* from 1935 to 1950. However, line *yz* is slightly steeper than *ab*.

The over-all inference is that the crushed and broken stone industry is expanding at a faster rate than population growth since 1935.

Figures 10 and 11 show production curves for the different types of crushed and broken stone. The dotted lines superimposed are approximate trend lines but are not mathematically calculated; these trends, however, are interesting.

Rubble shows a decided downward trend, whereas riprap trends upward just as definitely. The curve for crushed stone is flat to 1935 and then slopes steeply upward. On the other hand, furnace flux fell off rapidly to 1935 and then recovered just as rapidly.

In Figure 11 refractory stone showed a downward trend to 1935 and then picked up rapidly until 1944, when it again slumped. A somewhat similar trend is shown for agricultural stone except that the apparent slump was not noticeable until 1947.

Stone for other uses shows an upward trend to 1935, accelerating after that year. The trend for the total crushed and broken stone industry, while showing little vitality before 1935, shows every evidence of rapid expansion since that year.

Figure 8 illustrates significantly how the stone industry is closely related to the construction industry. While population increase has an indirect effect in the long run and highway construction and the steel industry lend helping hands, the real indicator of progress in the crushed and broken stone industry is the status of the nation's total construction activity.

In the discussion under "Prices and Costs," it was shown how prices (as expressed by plant values reported to the Bureau of Mines) of stone for most uses have advanced only slightly in the past 25 years, particularly when comparisons are reduced to a constant dollar value. To further illustrate this point, Figure 12 has been drawn. In this figure the plant values of crushed stone have been recalculated to give index values based on the 1926 value as 100.

The solid line shows the index of crushed stone values. The dotted curve represents a price index for building materials, and the dashed line the price index for all commodities.

A study of these curves shows the price index for crushed stone lagging far behind the others.

To further illustrate this phenomenon, the value per short ton for crushed stone is plotted in Figure 13; the dotted curve added was calculated from those values but was based on the 1939 dollar value. This dotted curve actually goes downward while the monetary value goes up from 1941 to 1950.

It appears that the crushed stone industry has been enjoying a healthy growth in recent years but at the expense of price lagging behind prices of other materials in kindred industries.

TABLE VII

TRENDS IN NUMBER AND SIZE OF PLANTS, 1941–50

Size Group, Annual Production, Short Tons	Number of Plants			Production, Short Tons		
	1941	1950	Per cent Change	1941	1950	Per cent Change
Less than 1,000	141	49	− 65.0	99,460	22,950	− 75.5
1,000–25,000	805	471	− 41.5	7,639,860	5,044,040	− 34.0
25,000–50,000	254	251	− 1.2	8,893,690	9,190,720	+ 3.3
50,000–75,000	141	185	+ 31.2	8,655,220	11,387,660	+ 31.6
75,000–100,000	82	140	+ 70.7	7,125,430	12,058,880	+ 69.2
100,000–200,000	147	236	+ 60.5	21,549,890	33,563,530	+ 55.8
200,000–300,000	58	103	+ 77.6	14,235,700	25,020,380	+ 75.8
300,000–400,000	39	72	+ 84.6	13,556,340	24,903,960	+ 83.7
400,000–500,000	29	31	+ 6.9	13,139,480	13,852,520	+ 5.4
500,000–600,000	7	15	+ 114.3	3,850,070	8,346,320	+ 116.8
600,000–700,000	5	15	+ 200.0	3,243,550	9,593,000	+ 195.8
700,000–800,000	6	12	+ 100.0	4,494,440	9,042,710	+ 101.0
800,000–900,000	4	10	+ 150.0	3,367,900	8,753,870	+ 160.0
900,000 and over	19	32	+ 68.4	33,186,870	58,208,790	+ 75.4
Total	1,737	1,622	− 6.6	143,037,900	228,989,330	+ 60.0

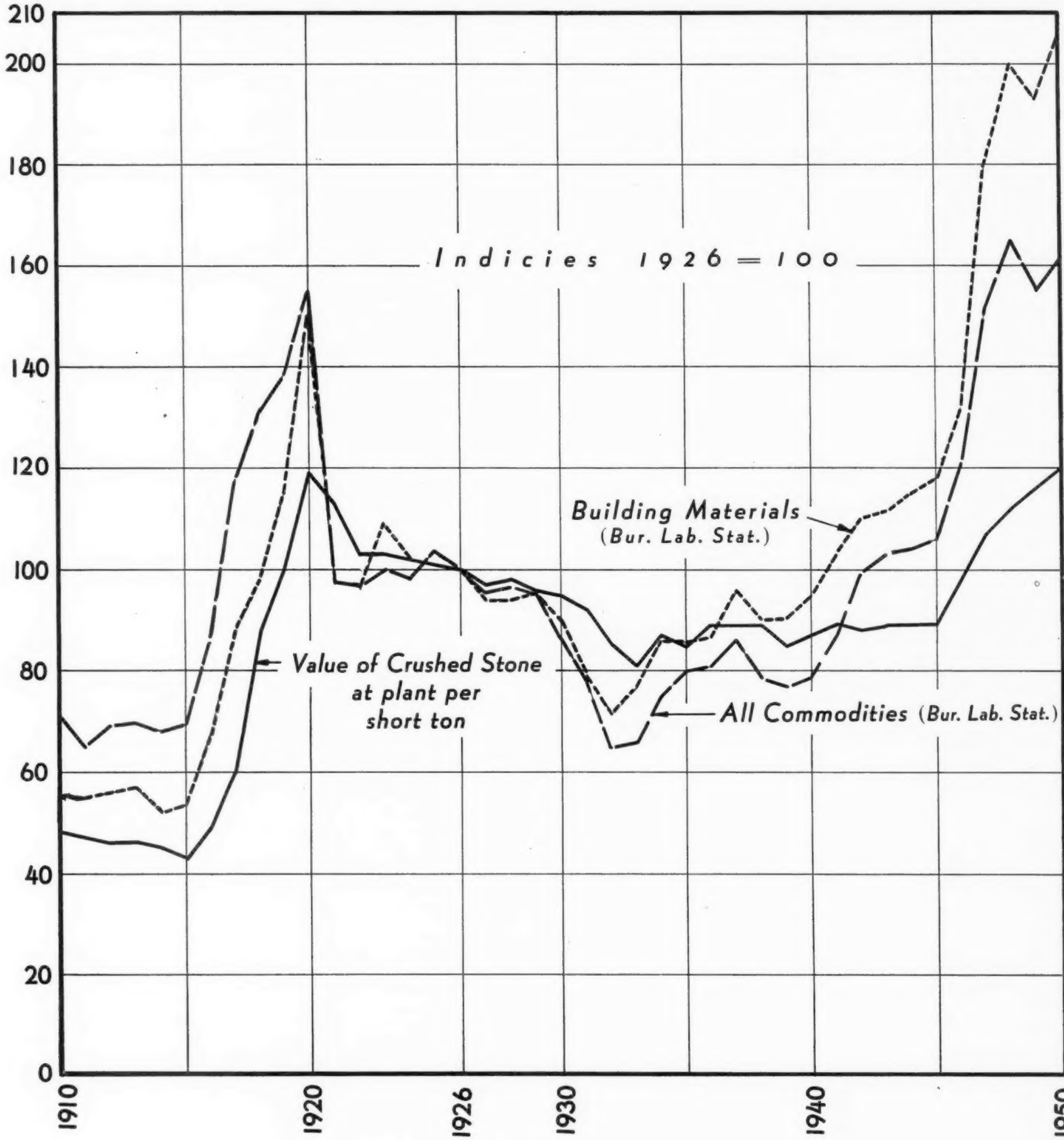

FIGURE 12
Comparison of Price Indices

Obviously, there must be a valid economic reason for this apparent anomaly. Under the heading "Substitutes" it was pointed out that crushed stone had formidable competition from other mineral aggregates. Most of these are lower cost materials than crushed stone, and it may be that the necessity of meeting this competition has been a primary reason for the industry price anomaly.

Table II compares the number of plants and production by size groups for the years 1941 and 1950. Table VII presents the same data but also shows the change in 1950 from 1941 in per cent of 1941 figures. It is of interest to note that:

1. The total number of commercial plants decreased 6.6 per cent, but this decrease in numbers occurred only in the then lowest categories. Actually, the number of plants in each group above 50,000 tons increased.
2. The total production from all plants increased 60 per cent.
3. The average production per plant increased from 82,000 in 1941 to 141,000 tons in 1950, or 72 per cent.

Table II shows that two-thirds of the production during each year came from 97 per cent of the plants. However, in 1941 these plants were in those groups producing less than 500,000 tons annually, whereas in 1950 these plants had increased in size to the 600,000- to 700,000-ton group.

Conversely, one-third of the production in 1941 came from 41 or 2.3 per cent of the plants, while in 1950 the same proportion of the tonnage came from 54 or 3.3 per cent of the plants. Those plants producing this third of the total production averaged 1,174,000 tons per plant in 1941 and 1,400,000 tons per plant in 1950. Hence, not only did the number of plants increase 32 per cent, but the average plant production increased 19 per cent.

In the smaller size group (97 per cent) the average production per plant increased from 56,000 to

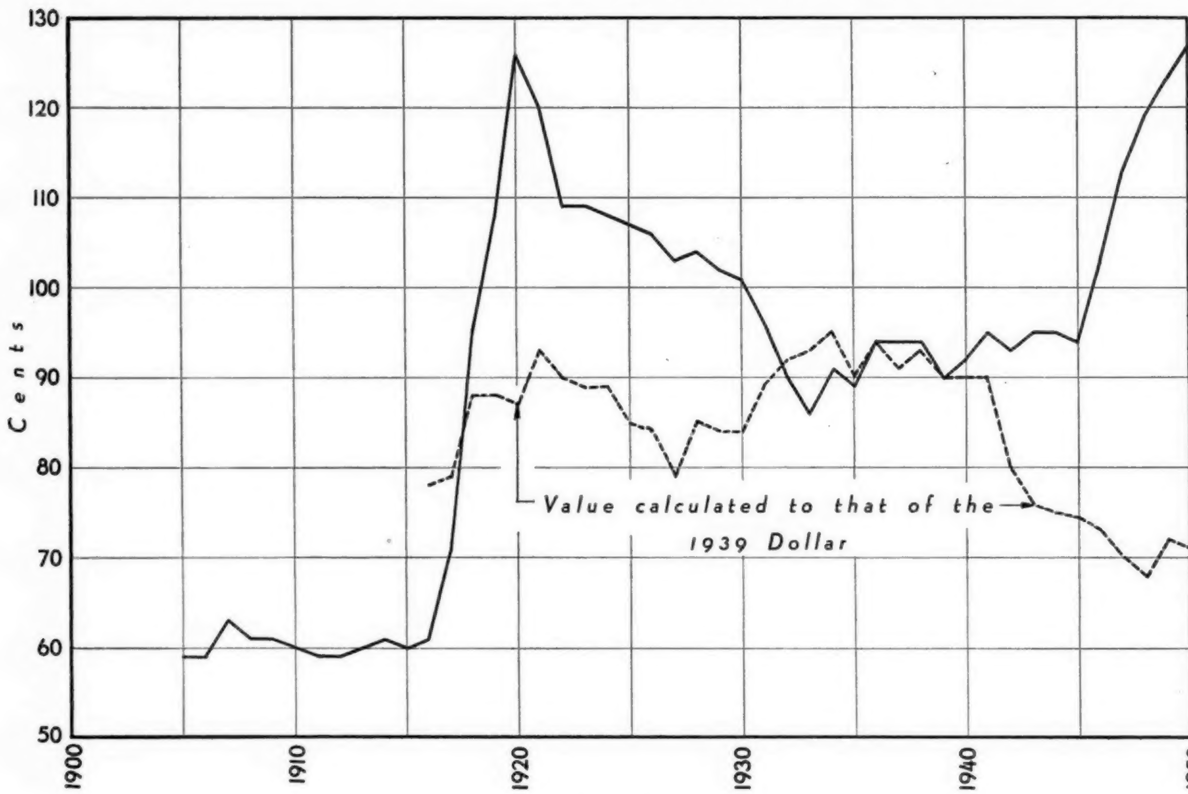

FIGURE 13

Value per Short Ton for Crushed Stone
(Bureau of Mines Minerals Yearbook)

97,500 tons, or 74 per cent. In this group there was a decrease of 128 in the number of plants, or 7.5 per cent.

As may be noted from Table VII, the group showing the greatest percentage increase in number of plants and tonnage produced is the 600,000- to 700,000-ton group. However, Table II shows that this group represented less than 1 per cent of the plants and only slightly over 4 per cent of the production in 1950.

The greatest increase appears to be in the four groups ranging from 75,000 to 400,000 tons annually. These four groups comprised 19 per cent of the plants in 1941 and 34 per cent in 1950, and each year they produced roughly 40 per cent of the total production (Table II). It is a rather remarkable coincidence that the average production *per plant* in this group was the same (173,000 tons) for 1941 and 1950. Moreover, each size group of these four averaged virtually the same tonnage per plant for the two years. Obviously, then, the increased tonnage of these four groups cannot be credited to increased plant production but must be accounted for by increased number of plants.

Further study shows that the four groups ranging in size from 75,000 to 400,000 tons showed an increase in number of plants in 1950 over 1941 of 225 During the same period the four smaller size groups (0 to 75,000) lost 385 plants. There was a total loss in all size groups of 115 plants. This would seem to indicate that roughly the equivalent of 115 plants of the first four groups went out of business, 225 expanded into the 75,000- to 400,000-ton class, and 45 increased from that group to the 400,000- to over 900,000-ton group.

The trend appears to be toward increased plant size, the preferred sizes ranging from an annual production of 75,000 to 400,000 tons.

Curtiss to Head BPR

Administration of the U. S. Bureau of Public Roads will be taken over on Jan. 1 by Capt. C. D. Curtiss, and F. V. du Pont will resign as Commissioner to become special assistant to the Secretary of Commerce, according to announcement by Mr. du Pont.

Captain Curtiss joined the Bureau in 1919 and has been Deputy Commissioner since 1943.

Mr. du Pont says he will terminate all administrative duties with BPR. He is expected to devote himself to advancing President Eisenhower's highway legislative program.—*Road Builders' News*

Quarry Operators to Meet in Cincinnati

(*Continued from Page 4*)

the University of Idaho, took office as President of the Asphalt Institute, and about the first of the year the organization's offices will be moved to College Park, Maryland, just outside of Washington, D. C., where a greatly expanded research program will be undertaken. It is most timely, therefore, that we have President Buchanan address us on Wednesday afternoon on the subject "The Role of the Asphalt Institute in the Asphalt Paving Industry."

"Human Response to Blast Produced Vibrations" will next be presented by Jules Jenkins, President of Vibration Measurement Engineers in Chicago. Recent developments in this field have been truly startling and should be of growing interest to crushed stone producers. We can expect from Mr. Jenkins an informative and challenging presentation, and during the thirty minute discussion period which follows, opportunity will be afforded to ask questions. Mr. Jenkins has a highly important message for us and one from which all quarry operators should derive real benefit.

The final and concluding feature of the Cincinnati Convention will be the Reception and Annual Banquet on Wednesday evening, the last opportunity until a year hence to foregather with your fellow producers, friends, and guests, to spend a thoroughly enjoyable evening in an atmosphere of complete relaxation. For this occasion we have engaged "America's Knight of Satire," Art Briese. Widely known as a humorist of exceptional talents, he keeps his audience wondering, surprised, and laughing—surely the essential ingredients to a perfect evening of entertainment.

All Are Invited to Attend

Attendance at the forthcoming 38th Annual Convention of the National Crushed Stone Association is not restricted to members only, and this point can not be emphasized too strongly. All crushed stone producers and others interested in the crushed stone industry are cordially invited to attend. We urge, if you have not already done so, that you make hotel reservations immediately. Special reservation cards are available upon request to the Association, and their use insures preferential consideration in obtaining rooms for the Convention period.

Make your plans now to attend, certain in the knowledge that you will have a memorable and profitable three days in Cincinnati.

Road Rating Plan May Save Millions

A YOUNG California county road commissioner, H. E. Carlson, has devised a new highway rating plan that some experts feel may, in effect, save the nation countless millions of dollars over the next two or three decades.

The plan has been cited by H. S. Fairbank, deputy commissioner of the Bureau of Public Roads, as "an invaluable tool in determining highway policy by county authorities." Mr. Fairbank advised division engineers of the bureau throughout the country to explore fully the possibilities outlined in the plan.

Prepared basically as an engineering study, Mr. Carlson's procedures make it possible for primary needs of both the state highway department and county road building authorities to be met with a maximum of efficiency in the expenditure of public funds.

Mr. Carlson's technique starts with the so-called "sufficiency rating" approach to the county road problem but he supplements it with data on maintenance and construction costs and with information on the revenue potential from use of individual road sections.

Highway engineers are aware, of course, of basic elements that must be considered in determining a road's adequacy. These are geometric design, physical condition, safety and the amount of service which the road gives to a community. The problem of considering these elements for every road section requires a wealth of design, traffic and physical condition data.

Collection of data was the first step taken by Mr. Carlson and his assistants. In order to determine the average daily traffic over each "rural" road in a 1,060 mile county road system, mechanical and personal counts were examined. Adjustments were made for the seasonal variations.

Records for the various roads were then divided into five different groups, depending on daily traffic: 0-50 vehicles per day, 50-100, 100-400, 400-1,000 and 1,000-4,000. The standard to which each type of road should be constructed was then adopted for each traffic grouping.

Only then did Mr. Carlson move on to the basic elements of geometric design, physical condition, safety and service. And to each of these four fundamental elements of road adequacy he gave a rating. This gave him a road adequacy point rating which could range from zero for the worst possible condition to 100 for a completely adequate section. To this finally was added a formula for determining a priority schedule which included the economics of highway construction and maintenance.

Planning and budgeting programs are greatly simplified because the most deficient road with the highest economic justification is obviously No. 1 on the priority list.—*Highway Highlights*

AMA Backs President's Road Program

ACTING to give fullest possible support to President Eisenhower's plea for a $101-billion, ten-year highway building program, the Automobile Manufacturers Association has adopted a precedent-setting AMA highway policy.

Key feature of the policy is a recommendation that the federal government take over the full cost of modernizing the 40,000-mile Interstate Highway System. The interstate net includes the most heavily traveled routes of the present federal-aid system of highways. For the past 33 years the automotive industry has strongly supported the long-standing limitation of federal funds to no more than half of construction costs on any road.

William J. Cronin, AMA managing director, said that "the present highway emergency makes it mandatory that the Interstate Highway System be rushed to completion during the next ten years. At the present rate of improvement the job will not be done for half a century."

Other features of the new AMA program call for:

1. Creation of a Federal Highway Authority empowered to use long-term financing to supplement today's insufficient tax revenues; use of similar financing by states and communities.

2. Doubling for ten years of the federal contribution to farm-to-market roads, main rural roads, and arterial city streets which make up most of the remainder of the present Federal-Aid System.

"Adoption of these recommendations," Cronin said, "represents a departure from traditional financing methods, but one that is absolutely essential if America is to get out of the current traffic mess. If these financing policies are put into effect, the $101-billion cost of this construction can be met with almost no need to look for more highway tax funds than are already available."—*Automobile Facts*

Manufacturers Division — National Crushed Stone Association

These associate members are morally and financially aiding the Association in its efforts to protect and advance the interests of the crushed stone industry. Please give them favorable consideration whenever possible.

Allis-Chalmers Mfg. Co.
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Crushing, Screening, Washing, Grinding, Cement Machinery; Motors; Texrope Drives; Centrifugal Pumps; Tractors

American Cyanamid Co.
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American Manganese Steel Division
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109 North Wabash Ave., Chicago 2, Ill.
Manganese and Alloy Steel Castings, Power Shovel Dippers, Material Handling Pumps, Reclamation and Hard-Facing Welding Materials

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1249 Macklind Ave., St. Louis 10, Mo.
Manufacturers of Ring Crushers and Hammermills for Primary and Secondary Crushing

American Steel & Wire Division
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Aquadyne Corp.
62 LaSalle Road, West Hartford, Conn.
"Wet Water"

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Shovel Loaders (Front End)

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Power Shovels, Draglines, Cranes, Bins, Conveyors and Idlers, Crushers and Pulverizers, Feeders, Plants—Crushing and Portable, Washing Equipment

Barber-Greene Co.
400 North Highland Ave., Aurora, Ill.
Portable and Permanent Belt Conveyors, Belt Conveyor Idlers, Bucket Loaders Both Wheel and Crawler Mounted, Asphalt Mixers and Finishers, Coal Handling Machines

Birdsboro-Buchanan Crusher Dept.
Birdsboro Steel Foundry & Machine Co.
1941 Furnace St., Birdsboro, Pa.
Primary and Secondary Crushers and Rolls

Brunner & Lay Rock Bit Corp.
P. O. Box 4247, Asheville, N. C.
Tungsten Carbide Detachable Bits, "Rock Bit" Drill Steel Inlaid with Tungsten Carbide, Carbon Hollow Drill Steel, Alloy Hollow Drill Steel

Bucyrus-Erie Co.
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Excavating, Drilling, and Material Handling Equipment

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Diesel and Gasoline Engines; Material Handling Equipment; Lifting Jacks; Earth Drills and Maintenance of Way Equipment

Cape Ann Anchor & Forge Co.
P.O. Box 360, Gloucester, Mass.
"Cape Ann" Forged Steel Drop Balls

Caterpillar Tractor Co.
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Track-Type Tractors, Bulldozers, Earthmoving Scrapers, Motor Graders, Heavy-Duty Off-Road Hauling Units, Diesel Engines, Diesel Electric Generating Sets, Front End Shovels for Tractors or Tractor Loaders, Wheel-Type Tractors

Chain Belt Co.
P. O. Box 2022, Milwaukee 1, Wis.
Rex Conveyors, Elevators, Feeders, Idlers, Elevator Buckets, Drive and Conveyor Chains, Sprockets, Bearings, Pillow Blocks, Power Transmission Equipment, Portable Self-Priming Pumps

Clark Equipment Co.
Construction Machinery Division
300 Miller St., Benton Harbor, Mich.
Truck and Crawler Excavator Cranes—3/8, 1/2, 3/4 Cu. Yd.; Tractor Shovels—15 Cu. Ft. Through 2 1/4 Cu. Yd.

Manufacturers Division—National Crushed Stone Association
(continued)

Continental Gin Co.
4500 Fifth Ave., S., Birmingham 2, Ala.
Conveyors—Belt, Screw, Flight and Underground Mine; Elevators—Bucket and Screw; Feeders—Apron, Belt, Reciprocating, Table, and Screw; Drives—V-Belts, Chains and Sprockets, Gears and Speed Reducers

Contractors and Engineers
470 Fourth Ave., New York 16, N. Y.
Magazine of Modern Construction

Cross Engineering Co.
P. O. Box 507, Carbondale, Pa.
Cross Perforated Steel Segments, Sections, Decks, for Vibrating, Shaking, Revolving, and Other Types of Screening Equipment

Cummins Engine Co., Inc.
Fifth and Union Sts., Columbus, Ind.
Lightweight Highspeed Diesel Engines (60-600 Hp.) for: On-Highway Trucks, Off-Highway Trucks, Buses, Tractors, Earthmovers, Shovels, Cranes, Industrial and Switcher Locomotives, Air Compressors, Logging Yarders and Loaders, Oil Well Drilling Rigs, Centrifugal Pumps, Generator Sets and Power Units, Work Boats and Pleasure Craft

Deister Machine Co.
1933 East Wayne St., Fort Wayne 4, Ind.
Deister Vibrating Screens, Classifiers, Washing Equipment

Detroit Diesel Engine Division
General Motors Corp.
13400 West Outer Drive, Detroit 28, Mich.
Light Weight, Compact 2 Cycle Diesel Engines and "Package Power" Units for All Classes of Service

Diamond Iron Works
Division Goodman Manufacturing Co.
Halsted Street & 48th Place, Chicago 9, Ill.
Jaw and Roll Crushers; Vibrator, Revolving, and Scrubber Screens; Drag Washers; Bucket Elevators; Belt Conveyors; Bins; Apron and Plate Feeders; Portable Gravel and Rock Crushing, Screening, and Washing Plants; Stationary Crushing, Screening, and Washing Plants; Hammermills

Du Pont, E. I., de Nemours & Co.
Wilmington 98, Del.
Explosives and Blasting Supplies

Dustex Corp.
1758 Walden Ave., Buffalo 25, N. Y.
Dust Collecting Equipment; Dust Control Systems

Eagle Iron Works
129 Holcomb Ave., Des Moines 13, Iowa
Fine Material Screw Washers—Classifiers—Dehydrators; Coarse Material Screw and Log Washers—Dewaterers; Water Scalping and Fine Material Settling Tanks; Drop Balls—Ni-Hard and Semi-Steel; "Swintek" Screen Chain Cutter Dredging Ladders

Easton Car & Construction Co.
Easton, Pa.
Off-Highway Transportation: Dump Trailers, Truck Bodies, and Cars for Mines, Quarries, and Earth Moving Projects

Ensign-Bickford Co.
Simsbury, Conn.
Primacord-Bickford Detonating Fuse and Safety Fuse

Euclid Division
General Motors Corp.
1361 Chardon Road, Cleveland 17, Ohio
Heavy-Duty Trucks and Dump Trailers for "Off-Highway" Hauls. Loaders for Earth Excavation, Single and Twin Engine Earth Moving Scrapers

Frog, Switch & Mfg. Co.
Manganese Steel Dept.
Carlisle, Pa.
Manufacturers of "Indian Brand" Manganese Steel Castings for all Types of Jaw, Gyratory, and Pulverizing Crushers; Dippers, Teeth, Treads, and Other Parts for Power Excavating Equipment; and Other Miscellaneous Manganese Steel Castings. Manufacturers and Fabricators of Railroad and Mine Frogs, Switches, and Crossings

General Electric Co.
1 River Road, Schenectady 5, N. Y.
Electric Motors, Controls, Locomotives, Welding Equipment, Coordinated Electric Drives for: Shovels, Drag Lines, Conveyors, Hoists, Cranes, Crushers, Screens, Etc.; Coordinated Power Generating and Distributing Systems Including Generators, Switchgear, Transformers, Cable, Cable Skids, Load Center Substations

Gill Rock Drill Co.
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Well Drill Tools and Supplies

Goodyear Tire & Rubber Co., Inc.
Akron 16, Ohio
Airfoam; Industrial Rubber Products—Belting (Conveyor, Elevator, Transmission), Hose (Air, Water, Steam, Suction, Miscellaneous); Chute Lining (Rubber); Rims (Truck and Tractor); Storage Batteries (Automobile, Truck, Tractor); Tires (Automobile, Truck, Off-the-Road); Tubes (Automobile, Truck, Off-the-Road, Life-Guard, Safety Tubes, Puncture Seal Tubes)

Manufacturers Division—National Crushed Stone Association
(continued)

Gruendler Crusher and Pulverizer Co.
2915 North Market St., St. Louis 6, Mo.
Rock and Gravel Crushing, Screening and Washing Plants, Jaw Crushers, Roll Crushers, Hammermills, Lime Pulverizers

Gulf Oil Corp.
Gulf Refining Co.
Gulf Bldg., Pittsburgh 19, Pa.
Lubricating Oils, Greases, Gasoline and Diesel Fuels

Haiss, George, Mfg. Co., Inc.
Subsidiary of Pettibone Mulliken Corp.
5720 Empire State Bldg., New York 1, N. Y.
Bucket Loaders, Buckets, Portable and Stationary Conveyors, Car Unloaders

Harnischfeger Corp.
4400 West National Ave., Milwaukee 14, Wis.
A Complete Line of Power Excavating Equipment, Overhead Cranes, Hoists, Smootharc Welders, Welding Rod, Motors and Generators, Diesel Engines

HarriSteel Products Co.
420 Lexington Ave., New York 17, N. Y.
Woven Wire Screen Cloth

Hayward Co.
50 Church St., New York 7, N. Y.
Orange Peel Buckets, Clam Shell Buckets, Electric Motor Buckets, Automatic Take-up Reels

Heidenreich, E. Lee, Jr.
Consulting Engineers
75 Second St., Newburgh, N. Y.
Plant Layout, Design, Supervision; Open Pit Quarry Surveys; Appraisals—Plant and Property

Hendrick Mfg. Co.
Carbondale, Pa.
Perforated Metal Screens, Perforated Plates for Vibrating, Shaking, and Revolving Screens; Elevator Buckets; Test Screens; Wedge Slot Screens; Open Steel Floor Grating

Hercules Powder Co.
Wilmington 99, Del.
Explosives and Blasting Supplies

Hetherington & Berner Inc.
701-745 Kentucky Ave., Indianapolis 7, Ind.
Asphalt Paving Machinery, Sand and Stone Dryers

Hewitt-Robins Incorporated
666 Glenbrook Road, Stamford, Conn.
Belt Conveyors (Belting and Machinery); Belt and Bucket Elevators; Car Shake-outs; Feeders; Industrial Hose; Screen Cloth; Sectional Conveyors; Skip Hoists; Stackers; Transmission Belting; Vibrating Conveyors, Feeders, and Screens; Design and Construction of Complete Plants

Hoyt Wire Cloth Co.
Abraso St., P. O. Box 22, Lancaster, Pa.
Aggregate Wire Screens Made of Super-tough and Abraso Wire—Smoothtop, Longslot, Oblong Space and Double Crimp Construction—For All Makes of Vibrators

Hughes Tool Co.
P. O. Box 2539, Houston 1, Texas
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Illinois Powder Mfg. Co.
506 Olive St., St. Louis 1, Mo.
Gold Medal Explosives

Ingersoll-Rand Co.
11 Broadway, New York 4, N. Y.
Rock Drills, Paving Breakers, Paving Breaker Tools and Accessories, Quarrymaster Drills, Drillmasters, Carset Bits, Jackbits, Bit Reconditioning Equipment, Portable and Stationary Air Compressors, Air Hoists, Slusher Hoists, Pneumatic Tools, Centrifugal Pumps, Diesel and Gas Engines

Insley Manufacturing Corp.
801 North Olney St., Indianapolis 6, Ind.
Concrete Carts and Buckets; 1/2 to 2 Cu. Yd. Cranes and Shovels—5 to 30 Tons Capacity—Rubber or Crawler Mounting

International Harvester Co.
Motor Truck Sales Dept.
180 N. Michigan Ave., Chicago 1, Ill.
Motor Trucks, Diesel and Gasoline Power Units; Crawler Tractors; Industrial Wheel Tractors

Iowa Manufacturing Co.
916 16th St., N.E., Cedar Rapids, Iowa
Rock and Gravel Crushing, Screening, Conveying and Washing Plants, Hot and Cold Mix Asphalt Plants, Stabilizer Plants, Impact Breakers, Screens, Elevators, Conveyors, Portable and Stationary Equipment, Hammermills, Bins

Jaeger Machine Co.
550 West Spring St., Columbus 16, Ohio
Portable and Stationary Air Compressors, Self-Priming Pumps, Truck Mixers, Concrete Mixers, Road Paving Machinery, Hoists and Towers; Rubber-Tired Front End Loaders

Jeffrey Manufacturing Co.
East First Ave., Columbus 16, Ohio
Elevator Buckets; Car Pullers; Chains; Conveyors: Belt, Drag, Apron, Vibrating; Idlers; Crushers; Pulverizers; Elevators; Feeders; Pillow Blocks; Stationary Plants; Screens

Manufacturers Division—National Crushed Stone Association

(continued)

Johnson-March Corp.
1724 Chestnut St., Philadelphia 3, Pa.
Dust Allaying Equipment

Joy Manufacturing Co.
333 Henry W. Oliver Bldg., Pittsburgh 22, Pa.
Drills: Blast-Hole, Wagon, Rock, and Core; Air Compressors: Portable, Stationary, and Semi-Portable; Aftercoolers; Portable Blowers; Carpullers; Hoists; Multi-Purpose and Portable Rock Loaders; Air Motors; Trench Diggers; Belt Conveyors; "Spaders"; "String-a-Lite" (Safety-Lighting-Cable); Backfill Tampers; Drill Bits: Rock and Core

Kennedy-Van Saun Mfg. & Eng. Corp.
2 Park Ave., New York 16, N. Y.
Crushing, Screening, Washing, Conveying, Elevating, Grinding, Complete Cement Plants, Complete Lime Plants, Complete Lightweight Aggregate Plants, Synchronous Motors, Air Activated Containers for Transportation of Pulverized Material, Cement Pumps, and Power Plant Equipment

Kensington Steel Co.
505 Kensington Ave., Chicago 28, Ill.
Oro Alloy and Manganese Steel Castings: For Shovels—Dipper Teeth, Crawler Treads; For Crushers—Jaw Plates, Concaves, Mantles, Bowl Liners; For Pulverizers—Hammers, Grate Bars, and Liners; For Elevators and Conveyors—Chain, Sprockets; For Tractors—Rail Links and Grouser Plates; Drag Line Chain

King Powder Co., Inc.
Cincinnati, Ohio
Detonite, Dynamites, and Blasting Supplies

Koehring Co.
3026 West Concordia Ave., Milwaukee 16, Wis.
Excavating, Hauling, and Concrete Equipment

Le Roi Co.
Cleveland Rock Drill Division
12500 Berea Road, Cleveland 11, Ohio
Air Compressors—Portable 60 Cfm. to 600 Cfm. Gas or Diesel; Tractairs—Combined Tractor with 105 Cfm. Air Compressor; Engines; Generator Sets; Rock and Wagon Drills; Jumbo Drill Rigs, Drifters, Stopers, Self Propelled Drill Rigs; Concrete Mixers; Front End Loaders

Linde Air Products Co., Division of Union Carbide and Carbon Corp.
30 East 42nd St., New York 17, N. Y.
Oxygen, Acetylene, Welding and Jet Piercing Equipment and Supplies

Link-Belt Co.
300 West Pershing Road, Chicago 9, Ill.
Complete Stone Preparation Plants; Conveyors, Elevators, Screens, Washing Equipment, Speed-O-Matic Shovels—Cranes—Draglines and Power Transmission Equipment

Link-Belt Speeder Corp.
1201 Sixth St., S. W., Cedar Rapids, Iowa
Complete Line of Power Hydraulically Controlled Cranes, Shovels, Trench Hoes, Draglines, Clamshells, 1/2 to 3 Yd. Capacities. Available on Crawler Base or Rubber Tire Mounting

Ludlow-Saylor Wire Cloth Co.
634 South Newstead Ave., St. Louis 10, Mo.
Woven Wire Screens and Wire Cloth of Super-Loy, Steel, and All Commercial Alloys and Metals

Mack Motor Truck Corp.
350 Fifth Ave., New York 1, N. Y.
On- and Off-Highway Trucks, Tractor-Trailers, Six-Wheelers, from 5 to 30 Tons Capacity, both Gasoline- and Diesel-Powered

Marion Power Shovel Co.
617 West Center St., Marion, Ohio
A Complete Line of Power Shovels, Draglines, and Cranes

McLanahan & Stone Corp.
252 Wall St., Hollidaysburg, Pa.
Complete Pit, Mine, and Quarry Equipment—Crushers, Washers, Screens, Feeders, Etc.

Murphy Diesel Co.
5317 West Burnham St., Milwaukee 14, Wis.
Engines and Power Units—90 to 246 Hp.; Generator Sets—60 to 154 Kw.; Marine Engines—90 to 225 Hp.; Dual-Fuel Engines—135 to 180 Hp.; Mechanical and Electric Power Simultaneously

National Container Corp. of Ohio
Multi-Wall Paper Bag Division
Jaite, Ohio
Multi-Wall Paper Bags, Sewn and Pasted Style for Packaging Lime, Cement, Plaster, Etc.

New York Rubber Corp.
100 Park Ave., New York 17, N. Y.
Conveyor Belting: Stonore, Dependable, and Cameo Grades; Transmission Belting: Silver Duck Duroflex, Soft Duck Rugged, Commercial Grade Tractor

Manufacturers Division—National Crushed Stone Association

(continued)

Nordberg Mfg. Co.
Milwaukee 1, Wis.
Symons Cone and Gyratory Crushers; Gyradisc; Grinding Mills; Stone Plant and Cement Mill Machinery; Vibrating Screens and Grizzlies; Diesel Engines and Diesel Driven Generator Units; Mine Hoists; Track Maintenance Machinery

Northern Blower Co.
6409 Barberton Ave., Cleveland 2, Ohio
Dust Collecting Systems, Fans—Exhaust and Blower

Northwest Engineering Co.
135 South LaSalle St., Chicago 3, Ill.
Shovels, Cranes, Draglines, Pullshovels—Crawler and Truck Mounted

Olin Mathieson Chemical Corp.
Explosives Division
East Alton, Ill.
Dynamite, Black Powder, Blasting Caps, Blasting Supplies

Osgood-General
P. O. Box 515, Marion, Ohio
Power Shovels, Cranes, Draglines, Hoes, Etc., 3/8 to 2 1/2 Cu. Yd.

Pennsylvania Crusher Division
Bath Iron Works Corp.
323 South Matlack St., West Chester, Pa.
Single Roll Crushers, Impactors, Hammermills, Ring Type Granulators, Kue-Ken Jaw Crushers, Kue-Ken Gyracones, Dixie Non-Clog and Standard Hammermills

Pettibone Mulliken Corp.
4710 West Division St., Chicago 51, Ill.
Material Handling Buckets, Clamshells, Draglines, Pullshovels, Dippers, Shovel Dippers, Pumps, Hammermills, Front End Loaders, Bucket Conveyor Loaders, Fork and Bucket Loaders, Speed Swing Loaders, Speed Swing Yard Cranes, Motor Graders, Manganese Steel Castings

Pioneer Engineering Works, Inc.
1515 Central Ave., N. E., Minneapolis 13, Minn.
Jaw Crushers, Roll Crushers (Twin and Triple), Vibrating and Revolving Screens, Feeders (Mechanical, Grizzly, Apron, and Pioneer-Oro Manganese Steel) Belt Conveyors, Portable and Stationary Crushing and Screening Plants, Washing Plants, Mining Equipment, Cement and Lime Equipment, Asphalt Plants and Finishers

Pit and Quarry Publications, Inc.
431 South Dearborn St., Chicago 5, Ill.
Pit and Quarry, Pit and Quarry Handbook, Pit and Quarry Directory, Concrete Manufacturer, Concrete Industries Yearbook

Productive Equipment Corp.
2926 West Lake St., Chicago 12, Ill.
Vibrating Screens

Quaker Rubber Corp.
Division of H. K. Porter Co. of Pittsburgh
Tacony and Milnor Sts., Philadelphia 24, Pa.
Conveyor Belts, Hose, and Packings

Radio Corporation of America
Engineering Products Department
Industrial Equipment Section
Front and Cooper Sts., Bldg. 15-1, Camden 2, N. J.
Electronic Metal Detectors

Rock Products
309 West Jackson Blvd., Chicago 6, Ill.

Rogers Iron Works Co.
11th and Pearl Sts., Joplin, Mo.
Jaw Crushers, Roll Crushers, Hammermills, Vibrating Screens, Revolving Screens and Scrubbers, Apron Feeders, Reciprocating Feeders, Roll Grizzlys, Conveyors, Elevators, Portable and Stationary Crushing and Screening Plants, Mine Hoists, Drill Jumbos and Underground Loaders

Screen Equipment Co., Inc.
1754 Walden Ave., Buffalo 25, N. Y.
Seco Vibrating Screens

Simplicity Engineering Co.
Durand, Mich.
Simplicity Gyrating Screens, Horizontal Screens, Simpli-Flo Screens, Tray Type Screens, Heavy Duty Scalpers, D'Watering Wheels, D'Centegrators, Vibrating Feeders, Vibrating Pan Conveyors, Car Shake-Outs, Woven Wire Screen Cloth

SKF Industries, Inc.
Front St. and Erie Ave., P. O. Box 6731, Philadelphia 32, Pa.
Anti-Friction Bearings—Self-Aligning Ball, Single Row Deep Groove Ball, Angular Contact Ball, Double Row Deep Groove Ball, Spherical Roller, Cylindrical Roller, Ball Thrust, Spherical Roller Thrust; Pillow Block and Flanged Housings—Ball and Roller

Smith Engineering Works
532 East Capitol Drive, Milwaukee 12, Wis.
Gyratory, Gyrasphere, Jaw and Roll Crushers, Vibrating and Rotary Screens, Gravel Washing and Sand Settling Equipment, Elevators and Conveyors, Feeders, Bin Gates, and Portable Crushing and Screening Plants

Manufacturers Division—National Crushed Stone Association

(concluded)

Stedman Foundry & Machine Co., Inc.

Aurora, Ind.

Stedman Impact-Type Selective Reduction Crushers, 2-Stage Swing Hammer Limestone Pulverizers, Multi-Cage Limestone Pulverizers, Vibrating Screens

Stephens-Adamson Mfg. Co.

Aurora, Ill.

Belt Conveyors, Elevators, Feeders, Car Pullers, Screens, Skip Hoists, Complete Plants

Talcott, W. O. & M. W., Inc.

91 Sabin St., Providence 1, R. I.

Belt Fasteners, Belt Lacing, Conveyor Belt Fasteners, and Patch Fasteners

Taylor-Wharton Iron & Steel Co.

High Bridge, N. J.

Manganese and other Special Alloy Steel and Iron Castings; Dipper Teeth, Fronts and Lips; Crawler Treads; Jaw and Cheek Plates; Mantles and Concaves; Pulverizer Hammers and Liners; Asphalt Mixer Liners and Tips; Manganese Nickel Steel Welding Rod and Plate

Thew Shovel Co.

East 28th St. and Fulton Rd., Lorain, Ohio

"Lorain" Power Shovels, Cranes, Draglines, Clamshells, Hoes, Scoop Shovels on Crawlers and Rubber-Tire Mountings. Diesel, Electric, and Gasoline, 3/8 to 2 Yd. Capacities

Torrington Co.
Bantam Bearings Division

3702 West Sample St., South Bend 21, Ind.

Anti-Friction Bearings; Self-Aligning Spherical, Tapered, Cylindrical, and Needle Roller; Roller Thrust; Ball Bearings

Travel Drill Co.

P. O. Box 1124, Raleigh, N. C.

"Travel Drill"—Mobile Drill for Secondary Drilling in Quarries and Open Pit Work

Traylor Engineering & Mfg. Co.

Allentown, Pa.

Stone Crushing, Gravel, Lime, and Cement Machinery

Trojan Powder Co.

17 North 7th St., Allentown, Pa.

Explosives and Blasting Supplies

Tyler, W. S., Co.

3615 Superior Ave., N. E., Cleveland 14, Ohio

Woven Wire Screens; Ty-Rock, Tyler-Niagara and Ty-Rocket (Mechanically Vibrated) Screens; Hum-mer Electric Screens; Ro-Tap Testing Sieve Shakers; Tyler Standard Screen Scale Sieves, U. S. Sieve Series

Unit Crane & Shovel Corp.

6411 West Burnham St., Milwaukee 14, Wis.

1/2 and 3/4 Cu. Yd. Crawler Mobile and Truck Mounted Shovels, Clamshells, Draglines, Cranes, Trenchoes, and Magnets

Universal Engineering Corp.

625 C Ave., N. W., Cedar Rapids, Iowa.

Jaw Crushers, Roll Crushers, TwinDual Roll Crushers, Hammermills, Impact Breakers, Pulverizers, Bins, Conveyors, Feeders, Screens, Scrubbers. Bulldog Non-Clog Moving Breaker Plate and Stationary Breaker Plate Hammermills, Center Feed Hammermills. A Complete Line of Stationary and Portable Crushing, Screening, Washing, and Loading Equipment for Rock, Gravel, Sand, and Ore. Aglime Plants. Asphalt Plants

Vibration Measurement Engineers

7665 Sheridan Road, Chicago 26, Ill.

Seismographic and Airblast Measurements, Seismological Engineering, Blasting Complaint Investigations, Expert Testimony in Blasting Litigation; Nation-wide Coverage

Werco Steel Co.

2151 East 83rd St., Chicago 17, Ill.

Castings—Manganese, Alloy Steel; Screen Plates—Perforated Steel Screen Sections and Decks; Buckets; Chains; Belt Conveyors, Idlers; Dipper—Shovel; Drop Balls; Wire Cloth; Wire Rope and Related Products

Weston Dump Body Co.

326 S.W. 11th St., Des Moines 9, Iowa

Combination Lime, Sand, and Gravel Body; Special Bodies for Quarry and Pit Work

White Motor Co.

842 East 79th St., Cleveland 1, Ohio

On- and Off-Highway Trucks and Tractors—Gasoline- and Diesel-Powered; Industrial Engines, Power Units, Axles, Special Machine Assemblies; All Classes of Service

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